STUART WELLER

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VOL. XII. April 30, 1899. **PART I.**

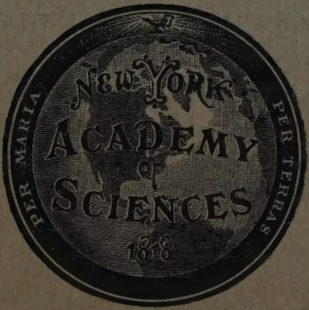
ANNALS

OF THE

NEW YORK ACADEMY OF SCIENCES.

Editor:

GILBERT VAN INGEN.



The New Era Printing Company,
Lancaster, Pa.

NEW YORK ACADEMY OF SCIENCES.

Officers, 1898–9.

President—Henry F. Osborn, American Museum of Natural History.

Vice-Presidents—J. F. Kemp, Charles L. Bristol.

Secretary—Richard E. Dodge, Teachers College, W. 120th St.

Corresponding Secretary—Wm. Stratford, College of the City of New York.

Treasurer—Charles F. Cox, Grand Central Depot.

Librarian—Bashford Dean, Columbia University.

Editor—Gilbert van Ingen, Columbia University.

SECTION OF ASTRONOMY AND PHYSICS.

Chairman—M. I. Pupin, Columbia University.

Secretary—W. S. Day, Columbia University.

SECTION OF BIOLOGY.

Chairman—Fred. S. Lee, Columbia University.

Secretary—F. E. Lloyd, Columbia University.

SECTION OF GEOLOGY AND MINERALOGY.

Chairman—Geo. F. Kunz, 15 Union Square.

Secretary—A. A. Julien, Columbia University.

SECTION OF ANTHROPOLOGY, PHILOLOGY AND PSYCHOLOGY.

Chairman—Lawrence A. McLouth, New York University.

Secretary for Philology—A. V. W. Jackson, Columbia University.

Secretary for Anthropology and Psychology—Chas. B. Bliss, New York University.

SESSION, 1898–1899.

The Academy will meet on Monday evenings at 8 o'clock, from October 3d to May 22d, in the rooms of the American Society of Mechanical Engineers, at **12 West 31st Street.**

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New York Academy of Sciences \ Annals

[Annals N. Y. Acad. Sci., Vol. XII, No. 1, pp. 1 to 40, April 21, 1899.]

CHARTER, ORDER OF COURT, CONSTITUTION AND BY-LAWS.

CHARTER.

AN ACT TO INCORPORATE THE

LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK.

Passed April 20, 1818.

Whereas, The members of the Lyceum of Natural History have petitioned for an act of incorporation, and the Legislature, impressed with the importance of the study of Natural History, as connected with the wants, the comforts, and the happiness of mankind, and conceiving it their duty to encourage all laudable attempts to promote the progress of science in this State—therefore,

Be it enacted by the People of the State of New York represented in Senate and Assembly, That Samuel L. Mitchill, Casper W. Eddy, Frederick C. Schaeffer, Nathaniel Paulding, William Cooper, Benjamin P. Kissam, John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements and James Pierce, and such other persons as now are, and may from time to time become members, shall be, and hereby are, constituted a body corporate and politic, by the name of Lyceum of Natural History in the City of New York, and that by that name they shall have perpetual succession, and shall be persons capable of suing and being sued, pleading and being impleaded, answering and being answered unto, defending and being defended, in all courts and places whatsoever; and may have a common seal, with power to alter the same from time to time; and shall be capable of purchasing, taking, holding and enjoying, to them and their successors, any real estate in fee simple or otherwise, and any goods, chattels and personal estate, and of selling, leasing, or otherwise disposing of said real or personal estate, or any part thereof, at their will and pleasure: *Provided always*, that the clear annual value or income of such real or personal estate shall not exceed the sum of five thousand dollars: *Provided*, however, that the funds of the said corporation shall be used and appropriated to the promotion of the objects stated in the preamble to this act, and those only.

2. *And be it further enacted*, That the said Society shall, from time to time, forever hereafter, have power to make, constitute, ordain, and establish such by-laws and regulations as they shall judge proper, for the election of their officers; for prescribing their respective functions, and the mode of discharging the same; for the admission of new members; for the government of the officers and members thereof; for collecting annual contributions from the members towards the funds thereof; for regulating the times and places of meeting of the said Society; for suspending or expelling such members as shall neglect or refuse to comply with the by-laws or regulations, and for the managing or directing the affairs and concerns of the said Society: *Provided* such by-laws and regulations be not repugnant to the Constitution and laws of this State or of the United States.

3. *And be it further enacted*, That the officers of the said Society shall consist of a President and two Vice-Presidents, a Corresponding Secretary, a Recording Secretary, a Treasurer, and five Curators, and such other officers as the Society may judge necessary; who shall be annually chosen, and who shall continue in office for one year, or until others be elected in their stead; that if the annual election shall not be held at any of the days for that purpose appointed, it shall be lawful to make such election at any other day; and that five members of the said Society, assembling at the place and time designated for that purpose by any by-law or regulation of the Society, shall constitute a legal meeting thereof.

4. *And be it further enacted*, That Samuel L. Mitchill shall be the President; Casper W. Eddy the First Vice-President; Frederick C. Schaeffer the Second Vice-President; Nathaniel Paulding, Corresponding Secretary; William Cooper, Recording

Secretary; Benjamin P. Kissam, Treasurer, and John Torrey, William Cumberland, D'Jurco V. Knevels, James Clements and James Pierce, Curators; severally to be the first officers of the said corporation, who shall hold their respective offices until the twenty-third day of February next, and until others shall be chosen in their places.

5. *And be it further enacted,* That the present Constitution of the said Association shall, after passing of this Act, continue to be the Constitution thereof; and that no alteration shall be made therein, unless by a vote to that effect of three-fourths of the resident members, and upon the request in writing of one-third of such resident members, and submitted at least one month before any vote shall be taken thereupon.

State of New York, Secretary's Office.

I CERTIFY the preceding to be a true copy of an original Act of the Legislature of this State, on file in this Office.

ARCH'D CAMPBELL,
Dep. Sec'y.

ALBANY, *April 29,* 1818.

ORDER OF COURT.

ORDER OF THE SUPREME COURT OF THE STATE OF NEW YORK
TO CHANGE THE NAME OF
THE LYCEUM OF NATURAL HISTORY IN THE CITY OF NEW YORK
TO
THE NEW YORK ACADEMY OF SCIENCES.

WHERAS, in pursuance of the vote and proceedings of this Corporation to change the corporate name thereof from "The Lyceum of Natural History in the City of New York" to "The New York Academy of Sciences," which vote and proceedings appear of record, an application has been made in behalf of said

Corporation to the Supreme Court of the State of New York to legalize and authorize such change, according to the statute in such case provided, by Chittenden & Hubbard, acting as the attorneys of the Corporation, and the said Supreme Court, on the 5th day of January, 1876, made the following order upon such application in the premises, viz :

At a special term of the Supreme Court of the State of New York, held at the Chambers thereof, in the County Court House, in the City of New York, the 5th day of January, 1876:

Present—HON. GEO. C. BARRETT, *Justice.*

In the matter of the application of the Lyceum of Natural History in the City of New York to authorize it to assume the corporate name of the New York Academy of Sciences.

On reading and filing the petition of the Lyceum of Natural History in the City of New York, duly verified by John S. Newberry, the President and chief officer of said Corporation to authorize it to assume the corporate name of The New York Academy of Sciences, duly setting forth the grounds of said application, and on reading and filing the affidavit of Geo. W. Quackenbush, showing that notice of such application had been duly published for six weeks in the State paper, to wit. *The Albany Evening Journal*, and the affidavit of David S. Owen, showing that notice of such application had also been duly published in the proper newspaper of the County of New York, in which county said Corporation has its business office, to wit, in the *Daily Register*, by which it appears to my satisfaction that such notice has been so published, and on reading and filing the affidavits of Robert H. Brownne and J. S. Newberry, thereunto annexed, by which it appears to my satisfaction that the application is made in pursuance of a resolution of the managers of said Corporation to that end named, and there appearing to me to be no reasonable objection to said Corporation so changing its name as prayed in said petition: Now on motion of Grosvenor S. Hubbard, of Counsel for Petitioner, it is

Ordered, That the Lyceum of Natural History in the City of New York be and is hereby authorized to assume the corporate name of The New York Academy of Sciences.

Indorsed: Filed January 5, 1876.

A copy. WM. WALSH, *Clerk.*

Resolution of THE ACADEMY, *accepting the order of the Court, passed February* 21, 1876.

And whereas, The order hath been published as therein required, and all the proceedings necessary to carry out the same have been had, Therefore:

Resolved, That the foregoing order be and the same is hereby accepted and adopted by this Corporation, and that in conformity therewith the corporate name thereof, from and after the adoption of the vote and resolution hereinabove referred to, be and the same is hereby declared to be

THE NEW YORK ACADEMY OF SCIENCES.

CONSTITUTION.

ARTICLE I.

This Society shall be styled The New York Academy of Sciences.

ARTICLE II.

It shall consist of four classes of members, namely : resident members, corresponding members, honorary members, and fellows. Resident members shall be such as live in or near the City of New York ; corresponding members, such as reside at a distance from said city ; and honorary members, such as may be judged worthy, from their attainments in science, to be admitted into the Academy. The number of honorary members shall not exceed fifty. Fellows shall be chosen from among the resident members, in virtue of scientific attainments or services.

ARTICLE III.

All fellows and members shall be elected by ballot. The names of candidates shall be proposed in writing, at least two meetings previous to being balloted for. The affirmative votes of three-fourths of the fellows and members present shall be necessary to elect a candidate ; honorary or corresponding members, however, may be elected without previous notice, provided that the ballot on such election is unanimous.

ARTICLE IV.

None but fellows or resident members shall be entitled to vote in the Academy.

ARTICLE V.

No fellow or member who shall be in arrears for one year shall be entitled to vote or be eligible to any office in the Academy.

ARTICLE VI.

The officers of the Academy shall consist of a president, a first and second vice-president, a corresponding secretary, a recording secretary, a treasurer, five curators, and a librarian, who shall be chosen annually on the fourth Monday in February.[1] The president, vice-presidents and secretaries shall be fellows. There shall also be elected, at the same time, a finance committee of three.

Article VII.

There shall be elected at the annual meeting six members, at least three of whom shall be fellows, who, together with the president, the vice-president, the two secretaries, and the treasurer, shall constitute a Council, by whom all business, to be brought before the Academy, shall ordinarily be prepared. Vacancies occurring in the offices or in the Council of the Academy in the interval between the annual elections, may be filled for the unexpired term by special election at any regular business meeting, provided notice of such election shall have been given at a previous regular business meeting.

Article VIII.

The election of officers and of the Council shall be by ballot, and the candidates having the greatest number of votes shall be declared duly elected.

Article IX.

Five members at an ordinary meeting shall form a quorum, and ten at a special or business meeting, a majority of whom, in either case, shall be fellows.

Article X.

By-laws for the further regulation of the Society may from time to time be made.

Article XI.

[2] No alteration shall be made in this Constitution, unless by a vote to that effect of three-fourths of the fellows and three-fourths of the resident members entitled to vote under Article V.

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[1] See eighth line of Section 3 of the Charter.

[1] This clause must be taken in connection with Section 5 of the Charter, which requires a previous request in writing of one-third of all the resident members (which must be considered in this case as including fellows, as that class of members was not in existence at the time the Charter was granted), submitted one month previous to any vote being taken.

BY-LAWS AMENDED TO DECEMBER 5, 1898.

CHAPTER I.

Officers.

1. *President.* It shall be the duty of the President, or, in his absence, one of the Vice-Presidents, to preside at the business and special meetings of the Academy; he shall exercise the customary powers of a presiding officer.

2. *Corresponding Secretary.* The Corresponding Secretary shall keep a corrected list of the Honorary and Corresponding members, their titles and addresses, and shall conduct all correspondence with them. He shall make a report to the Academy at the Annual Meeting.

3. *Recording Secretary.* The Recording Secretary shall keep the minutes of the Academy proceedings; he shall have charge of all documents belonging to the Academy; shall keep a corrected list of Resident Members and Fellows; shall send to Resident Members and Fellows announcements of the meetings of the Academy; shall notify all Members and Fellows of their election and committees of their appointment; shall give notice to the Treasurer and to the Council of matters requiring their action, and shall bring before the Academy business presented by the Council; he shall make a report to the Academy at the Annual Meeting.

4. *Treasurer.* The Treasurer shall have charge of all moneys belonging to the Academy, under the direction of the Council, and of their investment. He shall receive all fees, dues and contributions to the Academy, and any income that may accrue from property and investments; shall report at the Council meeting in January the names of members in arrears; shall keep the property of the Academy insured, and shall pay all debts against the Academy, the discharge of which shall be ordered by the Council. He shall report to the Council from time to time the state of the finances, and at the Annual Meeting shall report to the Academy the receipts and expenditures of the entire year.

5. *Librarian.* The Librarian shall have charge of the library, under the general authority of the Library Committee of the Council, and shall conduct all correspondence respecting exchanges of the Academy. He shall make a report on the condition of the library at the Annual Meeting.

6. *Other Officers.* The other officers of the Academy shall perform such duties as may be assigned to them by the Council.

CHAPTER II.

Council.

1. The Council shall meet once a month and shall have general charge of the affairs of the Academy. Past Presidents of the Academy, resident in New York, shall be advisory members of the Council, with the right to be present at the meetings and to serve on committees, but without vote; they shall be notified of all meetings.

2. *Quorum.* Five members of the Council shall constitute a quorum.

3. *Officers.* The President, Vice-Presidents and Recording Secretary of the Academy shall hold the same offices in the Council.

4. *Committees.* The Council shall organize within itself a Committee on Publications and a Committee on the Library; the action of these committees shall be subject to revision by the Council.

CHAPTER III.

Finance Committee.

1. The Finance Committee shall have the duties and powers of a committee on ways and means; it shall audit the annual report of the Treasurer, and shall report on financial questions whenever called upon to do so by the Council.

CHAPTER IV.

Elections.

1. *Resident Members.* Resident members shall be elected as follows: Candidates may be nominated publicly in writing at any meeting, and such nominations shall be referred to the

Council; if approved by the Council candidates may be elected at any succeeding business meeting. (See Art. III. of Constitution.)

2. *Fellows.* Fellows shall be elected as follows: Candidates may be nominated by the Council in writing at the business meeting in January or February, and shall then be balloted for at the subsequent Annual Meeting.

3. *Honorary and Corresponding Members.* Honorary and Corresponding Members may be nominated by the Council in writing at the business meeting in January or February, and elected at the subsequent Annual Meeting. Only persons eminent in some branch of science shall be eligible to corresponding membership.

4. *Officers and Councillors.* Officers and Councillors shall be elected at the Annual Meeting as follows: Nominations may be sent in writing to the Recording Secretary, with the name of the proposers, at any time not less than thirty days before the Annual Meeting, and the Council shall then prepare a list which shall be the regular ticket; this list shall be mailed to every Resident Member and Fellow at least two weeks before the Annual Meeting, but any Resident Member or Fellow shall be at liberty to prepare and vote another ticket. The election of Officers and Councillors shall be by ballot.

Chapter V.

Fees and Dues.

1. *Fees and Dues.* Every Resident Member shall pay an initiation fee of $5.00 within three months after his election, or such election shall be void. Annual dues of Resident Members and Fellows shall be $10.00, payable in advance at the time of the Annual Meeting; but new members elected after November 1st shall pay $5.00 for the remainder of the fiscal year.

2. *Members in Arrears.* If any Resident Member or Fellow, in arrears for his annual dues for over one year, shall neglect or refuse to pay the same within three months after notification by the Treasurer, his name may be erased from the rolls by a two-thirds vote of the Council.

3. *Renewal of Membership.* Any Resident Member or Fellow who shall resign because of removal to a distance from the City of New York may by a vote of the Council be restored to membership or fellowship at any time upon application, and without payment of an initiation fee.

CHAPTER VI.

Original Subscribers, Patrons and Life Members.

1. *Original Subscribers.* Every person holding a receipt for the sum of $100 (whether as original owner, transferee or legatee), paid toward the liquidation of the debt incurred in the erection of the building formerly the property of the New York Lyceum of Natural History, shall be deemed an Original Subscriber. Original Subscribers and their families shall be admitted to all lectures before the Academy, and shall be entitled to use the library.

2. *Patrons.* Any person contributing at one time $1,000[1] to the general funds of the Academy shall be a Patron, and shall during life be entitled to the same privileges as an Original Subscriber, and in addition to one copy of all subsequent publications of the Academy.

3. *Life Members.* Any Resident Member contributing at one time $100 towards the general fund of the Academy shall be a Life Member, and shall thereafter be exempt from annual dues. Any person becoming a Life Member immediately upon election as a Resident Member shall be exempt from an initiation fee.

CHAPTER VII.

Sections.

1. *Sections.* Sections devoted to special branches of science may be established or discontinued by the Academy on the recommendation of the Council.

2. *Organization.* Each section shall be organized with a chairman and a secretary who shall have charge of the meetings of their section.

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[1] Patron's Fee was raised from $250 to $1,000 in 1898.

CHAPTER VIII.

Meetings.

1. *Business Meetings.* Business meetings of the Academy shall be held on the first Monday evening of each month from October to May inclusive.

2. *Sectional Meetings.* Sectional meetings shall be held on Monday evenings from October to May, inclusive, and at such other times as the Council may determine. The sectional meeting shall follow the business meeting when both occur on the same evening.

3. *Annual Meetings.* The meeting held on the fourth Monday in February shall be the Annual Meeting.

4. *Special Meetings.* A special meeting may be called by the Council, provided one week's notice be sent to each Resident Member and Fellow, stating the object of such meeting.

CHAPTER IX.

Order of Business.

1. *Business Meetings.* The following shall be the order of procedure at business meetings:

    1. Minutes of the previous business meeting.
    2. Report of the Council.
    3. Report of committees.
    4. Elections.
    5. Nominations for membership.
    6. Other business.

2. *Sectional Meetings.* The following shall be the order of procedure at sectional meetings.

    1. Minutes of the preceding meeting of the section.
    2. Nominations for membership.
    3. Presentation and discussion of papers.
    4. Other scientific business.

3. *Annual Meetings.* The following shall be the order of procedure at Annual Meetings:

    1. Minutes of the preceding Annual Meeting.
    2. Annual reports of the Corresponding Secretary, Recording Secretary, Treasurer, Librarian and other officers.

3. Election of Honorary and Corresponding Members and Fellows.

4. Election of officers for the ensuing year.

5. Annual address of the retiring President.

CHAPTER X.

Publications.

1. *Annals and Memoirs.* The established publications of the Academy shall consist of the Annals and Memoirs. They shall be issued by an Editor appointed by the Council, and shall be under the supervision of the Committee on Publications. One copy of all publications shall be furnished free to each Resident Member and Fellow, and one copy of each volume of Annals to all Honorary and to all Corresponding Members who may signify their desire to receive them.

2. *Publication Fund.* Contributions may be received for the publication fund, and the income thereof shall be applied toward defraying the expenses of the scientific publications of the Academy.

CHAPTER XI.

General Provisions.

1. *Debts.* No debt shall be incurred on behalf of the Academy unless authorized by the Council.

2. *Bills.* All bills submitted to the Council must be certified as to correctness by the officers incurring them.

3. *Investments.* All the permanent funds of the Academy shall be invested in United States, or in New York State securities, or in first mortgages on New York real estate, provided they shall not exceed 65% of the value of the property. All income from Patron's fees, Life membership fees, and initiation fees, shall be added to the permanent fund.

4. *Expulsion, etc.* Any member or Fellow may be censured, suspended or expelled, for violation of the constitution or bylaws, or for any other offence deemed sufficient, by a vote of three-fourths of the members and three-fourths of the Fellows present at any business meeting, provided such action shall have

been recommended by the Council at a business meeting, and one month's notice of such recommendation and of the offence charged shall have been given the member accused.

5. *Changes in By-laws.* No alteration shall be made in these by-laws unless it shall have been submitted publicly in writing at a business meeting, shall have been entered on the minutes with the names of the members or Fellows proposing the same, and shall be adopted by two-thirds of the members and Fellows present at a subsequent business meeting.

LIST OF FELLOWS AND RESIDENT MEMBERS.

f. = Fellows ; **l.** = Life Members ; **p.** = Patrons.

Adams, Edward D., 455 Madison Avenue.
Alexander, Chas. B., (l.) 120 Broadway.
Alexander, Henry M., (l.) 10 West 54th Street.
Allen, Dr. George S., 51 West 37th Street.
Allen, J. A., (f.) American Museum of Natural History.
Allen, T. F., M.D., (f.) 3 East 48th Street.
Amend, B. G., (f.) 120 East 19th Street.
Anderson, A. A., 93 Fifth Avenue.
Andreini, José M., 29 West 75th Street.
Anthony, R. A., (l.) 591 Broadway.
Arnold, E. S. F., (f.) Care of Newport Nat. Hist. Soc., Newport, R. I.
Astor, John Jacob, 23 West 26th Street.

Bailey, James M., (l.) 77 Madison Avenue.
Beach, Frederick C., 361 Broadway.
Beard, Daniel C., 204 Amity Street, Flushing, Long Island.
Beatty, A. Chester, 3 East 9th Street.
Beck, Fanning C. T., (f. l.) 78 East 56th Street.
Beers, M. H., 408–410 Broadway.
Bickmore, Prof. A. S., (f.) American Museum of Natural History.
Bien, Julius, 140 Sixth Avenue.
Biggs, Charles, 13 Astor Place.
Blake, Dr. Joseph A., (f.) 437 West 59th Street.
Bliss, Prof. Chas. B., (f. l.) 115 Washington Pl.
Boas, Dr. Franz, (f.) American Museum of Natural History.
Bolton, H. Carrington, Ph.D., (f. p.) Cosmos Club, Washington, D. C.
Boyd, James, 12 Franklin Street.
Bristol, Prof. Chas. L., (f.) University Heights.

Bristol, John I. D., 1 Madison Avenue.
Britton, N. L., Ph.D., (f. p.) N. Y. Botanical Garden, Bronx Park.
Brockway, Fred. J., M.D., 183 West 73d Street.
Brown, Hon. Addison, (f. p.) 45 West 89th Street.
Brown, Alfred S., 160 West 76th Street.
Brown, E. C., 741 St. Nicholas Avenue.
Brownell, Silas B., (f.) 322 West 56th Street.
Bruce, Catherine W., (l.) 810 Fifth Avenue.
Burnett, Douglass, 42 Livingston Street, Brooklyn, N. Y.
Burr, Prof. W. H., Columbia University.

Calkins, Gary N., Ph.D., (f.) The Beresford, West 81st Street.
Casey, Capt. Thomas L., U. S. A., (f. p.) U. S. Engineer Office, Norfolk, Va.
Caswell, John H., (f.) 11 West 48th Street.
Cattell, Prof. John McK., (f.) Columbia University.
Chamberlain, L. T., M.D., The Chelsea, 23d Street, bet. 7th and 8th Avenues.
Chandler, Prof. Chas. F., (f.) Columbia University.
Chapin, Chester W., (p.) 34 West 57th Street.
Chapman, Frank M., (f.) American Museum of Natural History.
Cheesman, Dr. Timothy M., (f.) 46 East 29th Street.
Chester, Prof. Albert H., 39 College Ave., New Brunswick, N. J.
Collingwood, Francis (f.) Elizabeth, N. J.
Conkling, Alfred R., 27 East 10th Street.
Constant, S. Victor, (l.) 420 West 23d Street.
Cook, James B., Memphis, Tenn.
Cooper, Hon. Edward, 12 Washington Square, N.
Cooper, Prof. F. T., 177 Warburton Avenue, Yonkers, N. Y.
Cornish, Robert H., 123 Claremont Avenue, Montclair, N. J.
Coster, C. H., (l.) 27 West 19th Street.
Cox, Charles F., (f.) 54 East 67th Street.
Crampton, Henry E., Jr., Columbia University.
Crow, A. Eugene, St. Andrews Hotel, 721 Western Boulevard.

Curtis, Henry S., Columbia University.
Curtis, Prof. John G., M.D., 327 West 58th Street.

Daily, W. H., 32 Old Jewry, London, E. C., England.
Daly, Hon. Chas. P., (f.) 84 Clinton Place.
Davies, Wm. G., 34 Nassau Street.
Davis, J. Woodbridge, Ph.D., 523 West 173d Street.
Day, Wm. S., 203 West 85th Street.
Dean, Prof. Bashford, Ph.D., (f.) Columbia University.
Delafield, M. L., Jr., (l.) 56 Liberty Street.
Dennett, Wm. S., M.D., 8 East 49th Street.
Devereux, W. B., Hotel San Remo, City.
Devoe, F. W., 101 Fulton Street.
DeWitt, W. G., 88 Nassau Street.
Dickerson, Edward N., Washington Life Building, 141 Broadway.
Dix, Rev. Morgan, D.D., 27 West 25th Street.
Dodge, Prof. R. E., (f.) Teachers College, West 120th Street.
Dodge, Wm. E., (p.) 262 Madison Avenue.
Donald, James M., Hanover Nat. Bank, 11 Nassau Street.
Doremus, Chas. A., Ph.D., (f.) 59 West 51st Street.
Doremus, Prof. R. Odgen, M.D., (f.) 241 Madison Avenue.
Douglas, James, (l.) 99 John Street.
Douglass, Alfred, 170 West 59th Street.
Douglass, Andrew E., (f.) 9 East 54th Street.
Draper, Mrs. M. A. P., 271 Madison Avenue.
Drummond, Isaac W., M.D., 436 West 22d Street.
Dudley, Henry, (f.) 56 West 57th Street.
Dudley, P. H., (f.) 80 Pine Street.
Dunham, Edward K, M.D., 338 East 26th Street.
Dwight, Jonathan, Jr., M.D., 2 East 34th Street.
Dyar, Harrison G., 243 West 99th Street.
Dyckman, Isaac M., 15 East 71st Street.

Egleston, Prof. Thomas, (f. p.) 35 West Washington Square.
Elliott, A. H., Ph.D., (l.) 4 Irving Place.
English, George L., 64 East 12th Street.

Eno, Wm. Phelps, 111 Broadway.
Eyerman, John, Easton, Pa.

Fargo, James C., 56 Park Avenue.
Farrand, Livingston, M.D., (f.) Columbia University.
Farrar, John N., M.D., 1271 Broadway.
Field, C. de Peyster, (p.) 21 East 26th Street.
Flemming, Robert L., 76 Montgomery Street, Jersey City, N. J.
Foley, Ernest, 108 East 62d Street.
Ford, James B., (l.) 507 Fifth Avenue.
Foster, L. S., 33 Pine Street.
Foster, Scott, 332 West 72d Street.
Frankland, Fred. W., 346 Broadway.
Freeborn, George C., M.D., 215 West 70th Street.
Frissell, A. S., 530 Fifth Avenue.

Gallatin, Frederick, 670 Fifth Avenue.
Garrettson, Francis T., 26 Broad Street.
Gibier, Paul, M.D., (f). 313 West 23d Street.
Giddings, Prof. F. H., Columbia University.
Godkin, E. L., 36 West 10th Street.
Gordon, Reginald, Ph.D., Columbia University.
Gould, Edwin, (p.) Dobbs Ferry, N. Y.
Gould, Frank J., Irvington, N. Y.
Gould, George J., (p.) 195 Broadway.
Gould, Miss Helen, (p.) Irvington, N. Y.
Gouley, J. W. S., M.D., 11 East 43d Street.
Greacen, Thomas E., 65 West 48th Street.
Green, Hon. Andrew H., 214 Broadway.
Greene, Jeannette B., M.D., 135 West 41st Street.

Hall, Prof. Robert W., University Heights.
Hallock, Prof. William, (f.) Columbia University.
Hascall, Mrs. Virginia K., 110 East 16th Street.
Havemeyer, William F., 29 West 19th Street.
Heller, Max, 76 East 90th Street.

Hering, Prof. Daniel W., (f.) University Heights.
Herrman, Mrs. Esther, (p.) 59 West 56th Street.
Herter, Christian A., M.D., 839 Madison Avenue.
Hewitt, Hon. Abram S., (f.) 9 Lexington Avenue.
Hewitt, Edward R., 119 East 18th Street.
Hinton, John H., M.D., (f. p.) 41 West 32d Street.
Hitchcock, Miss F. R. M., (f.) 4038 Walnut Street, Philadelphia, Pa.
Hoe, Henry, 91 John Street.
Hoffman, Rev. E. A., D.D., (l.) 1 Chelsea Square.
Hoffmann, S. V., Morristown, N. J.
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Wortman, J. L., (f.) American Museum of Natural History.

Youmans, Wm. J., M.D., (f.) 72 Fifth Avenue.

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Sloane, Samuel; 26 Exchange Place, New York City.

Weston, Henry; 29 Broadway, New York City.

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Agassiz, Alexander; Director Emeritus Museum Comparative Zoölogy, Harvard University, Cambridge, Mass. (1887).
Akerman, Richard, Ph.D.; Director General and Chief of Royal Board of Trade, Stockholm, Sweden (1876).
Auwers, Arthur; Professor of Physics and Mathematics, University of Berlin; Berlin, Germany (1898).

Barrois, Charles, M.D.; Adjunct Professor of Geology; Secretary Geol. Soc. of France; 37 Rue Pascal, Lille, France (1889).
Brooks, William K.; Professor of Invertebrate Zoölogy, Johns Hopkins University; Baltimore, Md. (1898).
Bunzen, Robert W., Ph.D.; Professor of Chemistry in Heidelberg University; 12 Bunzen Street, Heidelberg in Baden, Germany (1876).

Dallinger, Wm. Henry, LL.D., F.R.S.; Ingleside, Lee, London S. E., England (1887).
Darwin, George Howard, M.A., F.R.S.; Professor of Physics, Trinity College, Cambridge, England (1899).
Dawkins, W. Boyd; Professor of Geology and Paleontology, Victoria University, Owens College, Manchester, England (1876).
Dawson, Sir John Wm.; Emeritus Principal McGill University 293 University Street, Montreal, Canada (1876).

Flower, Sir William H., LL.D., F.R.S.; Late Director British Museum of Natural History; London, England (1887).

Frankland, Sir Edward; Foreign Secretary of the Royal Society of London; the Yews, Reigats Hill, Surrey, England (1879).

Geikie, Sir Archibald, F.R.S.; Director General of Geological Survey of Great Britain and Ireland; 28 Jermyn Street, London S. W., England (1876).

Geinitz, Hans Bruno; Professor of Paleontology and Mineralogy, Geheimrath., Dresden Mus. of Geol. and Archæol. 10 Lindenaw Strasse, Dresden, Germany (1876).

Gibbs, Wolcott, LL.D.; Professor Emeritus of the Application of Science to the Useful Arts, Harvard University. Newport, R. I. (1889).

Gill, David; Professor of Astronomy at the Observatory. Cape of Good Hope, Africa (1898).

Goodale, George Lincoln, M.D., LL.D.; Professor of Natural History and Botany, Harvard University, Cambridge, Mass. (1889).

Hæckel, Ernst, Ph.D.; Professor of Zoölogy in the University of Jena. Jena, Weimar, Germany (1894).

Hall, Asaph; Professor of Mathematics U. S. Naval Observatory. South Norfolk, Conn. (1889).

Hartlaub, Gustav, M.D.; Assistant Director Museum of Natural History. Bremen, Germany (1864).

Hauer, Franz Ritter von, Ph.D.; Hofrath, Supt. Royal Museum of Natural History. 7 Kirchbergstrasse, Vienna, Austria, (1864).

Hooker, Sir Joseph Dalton, LL.D., F.R.S.; Sunningdale, England (1879).

Hubrecht, Ambrosius, A.M.; Professor of Zoölogy and Comparative Anatomy in the University of Utrecht. Utrecht, Netherlands (1896).

Kelvin, The Right Hon. Lord, F.R.S.; President of the Royal Society of Edinburgh. University of Glasgow; or 28 Chester Square, London, England (1876).

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Kokscharow, Nicholas von; Professor of, Lêsnoj Inst. St. Petersburg, Russia (1879).

Lang, Victor E. von, Professor of Physics in the University of Vienna. Vienna, Austria (1876).

Langley, Samuel Pierpont; Secretary of Smithsonian Institution, Washington, D. C. (1887).

Lankester, E. Ray, LL.D., F.R.S.; Director British Museum of Natural History. Cromwell Road, London, England (1898).

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Pfeffer, Wm.; Professor of Botany in the University of Munich. Munich, Germany (1898).

Rayleigh, Lord, LL.D., F.R.S.; Professor of Natural Philosophy in the Royal Institution of Great Britain. Albemarle Street, Piccadilly, N. W., London (1899).

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Virchow, R.; Professor of Pathological Anatomy in Royal Friedrich-Wilhelms University. Berlin, Germany (1898).

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Achiardi, Antonio D., Ph.D.; Professor of Mineralogy and Meteorology in the University of Pisa. 12 Via San Martino, Pisa, Italy (1890).

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Alexander, Wm. DeWitt; Surveyor General of the Hawaiian Islands. Honolulu, Hawaii (1890).

Andrews, Dr. C. W.; British Museum of Natural History, London, England (1899).

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Bell, J. Graham; Washington, D.C. (1878).

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[Annals N. Y. Acad. Sci., Vol. XII, No. 2, pp. 41–56, April 22, 1899.]

A PALÆOZOIC TERRANE BENEATH THE CAMBRIAN.

Geo. F. Matthew.

(Read November 28, 1898.)

[Figures 1–4.]

CONTENTS.

PAGE.
1. The oldest Palæozoic Fauna (Etcheminian) 41
2. New Brunswick sections of the terrane 42
3. Newfoundland sections of the terrane 45
4. Distinctness of the Fauna from the Cambrian 52
5. Westward extension of the Etcheminian 54

1. The Oldest Palæozoic Fauna.

The author has for some years been aware of the existence of a fauna in the rocks below those that contain Paradoxides and Protolenus[1] in New Brunswick, eastern Canada, but the remains of the higher types of organisms found in these rocks were so poorly preserved and so fragmentary, that they gave a very imperfect knowledge of its nature.

To assure us that there had been living forms in the seas of that early time, other than Protozoa and burrowing worms, we had only the casts of Hyolithidæ, the mould of an Obolus, a ribbed-shell similar to Palæacmæa and portions of what appeared to be the arms and bodies of Crinoids.

These objects were found in the upper division of a series of rocks, immediately subjacent to the Cambrian strata containing Protolenus, etc. As a decided physical break was discovered between the strata carrying the objects named above, and those having Protolenus, it was thought that the underlying series was worthy of a distinctive name, and ETCHEMINIAN was chosen—derived from a tribe of aborigenes which inhabited this country before the advent of Europeans.

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[1] Trans. New York Acad. Sci., XIV, 101–153, Pl. I–XI, fig. 1.

In most countries the basement of the Palæozoic sediments seems almost devoid of organic remains. It has been thoroughly searched in Europe, but with very unsatisfactory results; and there seemed little hope that America would yield better returns. Nevertheless, the indications of a fauna obtained in the maritime provinces of Canada seemed to hold out a hope, that in some more favored region, these basement beds of the Palæozoic might yield remains in a better state of preservation.

With this hope the author last summer made a visit to a part of Newfoundland where Mr. J. P. Howley, the director of the Geological Survey of that island, had reported a clear section of sediments below the horizons of Paradoxides and *Agraulos strenuus.* Before describing the rocks of that district, however, it may be well to speak more fully of the corresponding terrane in New Brunswick, in which the relation of this series to the Cambrian was first observed, and the break between the two series of strata first demonstrated.

2. The New Brunswick Sections.

The accompanying general section will show the relations which the Cambrian and Etcheminian terranes bear to each other in the province of New Brunswick, and their attitude to the underlying Prepalæozoic Systems. The section, which cuts through all these terranes, shows how insignificant in bulk the whole Eopalæozoic is to the underlying Archæan masses. It is perhaps owing to the thinness of the Eopalæozoic rocks and the firm platform of older sediments on which they rest, that they have escaped severe metamorphism, and contain recognizable fossils at the present day; and yet withall there is a difference in the conditions of preservation of the organic remains of the Cambrian and those of Etcheminian age, so that it is not alone the greater recency of the former, which will account for the ease with which the fossils can be recognized, but the chemical changes which took place in the Etcheminian sediments, as well as different conditions existing at the time of their entombment, have tended to obliterate the Etcheminian organisms while the Cambrian have remained.

In the base of the Cambrian the Hyolithoid shells and the Foraminifera have preserved the substance of their tests, but in the older terrane this has been replaced by glauconite or, some other mineral substance; so that in many cases the structure is gone and only a cast of the fossil remains. Still there is no evidence that the Etcheminian sediments were consolidated before the deposition of the Cambrian, as they have given no fragments to the latter, and apparently have furnished only mud and sand, for the building up of the Cambrian layers.

Section North from St. John.—Although there is but slight evidence in the condition of the sediments of the greater antiquity of the Etcheminian, and the unconformity existing between it and the Cambrian, this break becomes manifest when the distribution of the two is traced in the field, for then we find that the older terrane was entirely eroded from large tracts of country before the deposition of the newer. The accompanying section, taken along a line from the harbor of St. John northward, (Fig. 1) shows an instance of such erosion. In the city of St. John a belt of Etcheminian strata crosses the southern end of the city, being exposed along the southern side of the basin of Cambrian rocks on which the city is built. On the north side of this

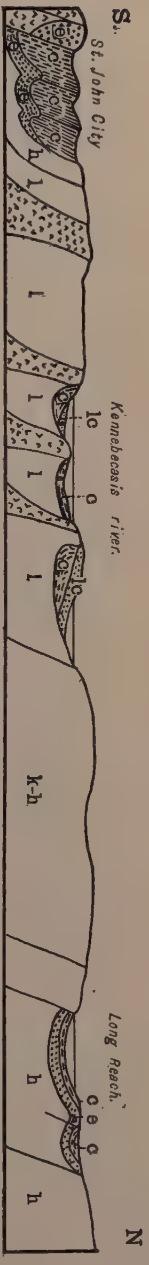

FIG. 1. Section from St. John northward through St. John and King's Counties. Scale 2½ miles to 1 inch. **l**, Laurentian, etc.; **h**, **k-h** Huronian; **e**, Etcheminian; **c**, Cambrian; **lc**, Lower Carboniferous.

basin the Etcheminian thins out and disappears in going westward.

Crossing from the St. John Basin to the one next northward containing Cambrian rocks, we find this to be one in which no Etcheminian rocks appear. The Etcheminian here has been entirely eroded before the deposition of the Cambrian, and this is the condition for many miles to the westward.

Passing over another plateau about five miles wide one reaches a third valley in which Cambrian sediments remain. Here we again meet beneath them the familiar red rocks of the Etcheminian, exposed along an anticline with Cambrian measures on both sides of it. The Etcheminian appears also along the north side of this basin and, so far as thickness of measures counts, is an important part of the Eopalæozoic sediments there.

Section on Hanford Brook.—In the eastern part of St. John County at Hanford Brook a clear section of the lower part of the Eopalæozoic is exposed, and is worthy of comparison with that of Smith Sound in Newfoundland described on a following page. From this section at Hanford Brook (Fig. 2) we see that the Huronian (Coldbrook) in Prepalæozoic times, formed in this area a district raised above the sea, against which a sea-beach deposit was made, the initial member of the Etcheminian. As the land sank the texture of the sediments changed, first to sand and then to clay. Subsequently there was a gradual re-elevation, so that flags alternated with the finer beds, and finally predominated in sandstones full of castings and burrows of worms. With added elevation of the land the condition of a sea beach

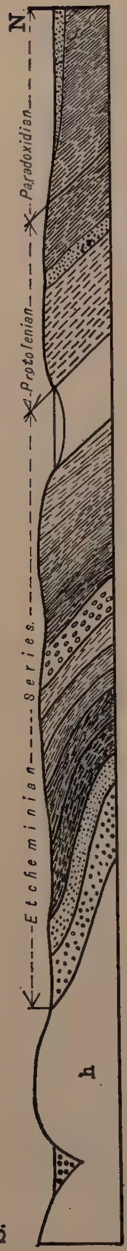

FIG. 2. Section of Eopalæozoic at Hanford Brook, St. John County, N. B., Can. Scale 700 feet to 1 inch.

with which the terrane begins, was restored. The resulting interraned conglomerate then sank, and clays and sands accumulated, in which are buried the remains of the fauna mentioned on a former page. From this point to the summit of the series somewhat coarser accumulations of sand and clay continue.

The Etcheminian terrane in New Brunswick, like the Cambrian, contains two cycles; each, in the Etcheminian, begins in a conglomerate, sands and fine shales follow, and then there is a return to coarser flags and sandstones toward the end. A similar succession, but of finer sediments can be traced in the St. John or Cambrian terrane,[1] and to this condition there is an approximate parallel in Newfoundland.

When one considers the softness of the Etcheminian sediments at the time of the deposition of the Cambrian it seems altogether likely that in the 1,200 feet of measures exposed on Hanford Brook, the entire thickness of the Etcheminian may not be represented, and this argument as to thickness also holds in Newfoundland, where a lesser thickness of beds is visible on Smith Sound, than is to be found in New Brunswick.

At several localities in southern New Brunswick masses of red shales, sandstones and conglomerates are seen, but as these are not accompanied by Cambrian strata, and are not known to contain definite fossils, there is no proof that any of them are of Etcheminian age.

3. The Newfoundland Sections.

So often do we find the basement beds of a Cambrian basin raised to a high angle of dip, or displaced by faults, leading to a doubt of the regularity in the succession of the beds, that one where the sequence is clear and continuous, and the dip low is deserving of careful examination. Such favorable conditions are present in the western of the two Cambrian basins on Smith's Sound in Trinity Bay, Newfoundland. Here the succession appears to be normal throughout, and besides the Etcheminian strata, it contains a series of beds extending to at least the summit of the Cambrian, since *Dictyonema flabelliforme* Eichw. was found in some of the higher beds. Even the rocks on which the Etcheminian rests, and which undoubtedly belong to an older system, are so little disturbed that no difference of dip was observed in passing to them from the Etcheminian.

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[1] Division 1 and Division 2*a* belong to the lower cycle, and Division 2*b* and *c* and Division 3 to the upper.

The small amount of disturbance which this basin has undergone is also shown by the absence of slaty cleavage, which so often obscures, or even obliterates, the organisms of the older Palæozoic rocks. These conditions were almost as favorable as those which exist in Sweden, for the study of the basement sediments of the Palæozoic.

As the author has already remarked, the rocks in eastern Canada, corresponding to these old Palæozoic layers in Newfoundland, are distinguished from the true Cambrian by a slight discordance of dip, and by evidence of erosion prior to the deposition of the Cambrian, and similar conditions prevail in Newfoundland. The latter feature is well shown at Manuel's Brook, where the Etcheminian is entirely eroded and the Cambrian rests directly upon feldspathic gneisses, felsites and ash rocks of the Intermediate or Huronian system. The relation of the Cambrian to the Huronian at this place has been shown by Mr. C. D. Walcott. It corresponds to the conditions in the Kennebecasis Valley in New Brunswick, where the basal beds of the Cambrain rest directly upon Laurentian rocks, without the intervention of the Etcheminian.

But at Smith Sound in Newfoundland a lower series of Palæozoic rocks, *i. e.*, the Etcheminian, separates the Cambrian from the Huronian. Here as at Manuel's Brook a conglomerate lies at the base of the Cambrian, the pebbles however, consist of fragments of slate and small blocks of limestone, similar in appearance to a bed of this rock occurring in the Etcheminian series a few hundred yards to the eastward. The conglomerate also contains lumps and elongated pieces of phosphate of lime intermingled with the limestone pebbles. The presence of this mineral, according to the studies of J. G. Andersson and H. Hedström in Sweden, show that beds in which it occurs were deposited along a shore line, or at least not very far from shore.

In the more easterly basin of the Eopalæozoic sediments on Smith Sound, the conglomerate at the base of the Cambrian is in more massive beds, and the fragments are largely small pebbles of red slate, derived from the Huronian terrane. This shows beds of such red slate a few hundred yards to the west of the place of the conglomerate.

The basal conglomerate of the Cambrian may therefore vary much in composition in the different localities where it has been recognized. It separates the Cambrian from the Etcheminian and indicates an emerged area of the latter sediments when the Cambrian rocks were being formed.

The Section at Smith Sound.—Three years ago Mr. J. P. Howley, the director of the Geological Survey of Newfoundland, sent to the writer a section of the Cambrian measures on the north shore of Smith Sound, together with some fossils which he had collected there and at Random Island on the south side of this sound. The fossils were found to be mostly of upper Cambrian age, there being an Olenus related to *O. cataractes*, Salt., a Parabolina having affinity with *P. spinulosa*, Wahl. and a Protopeltura resembling *P. acanthura*, Brögg. The Paradoxides zone was indicated by a few other fossils, viz., an Agraulos like *A. holocephalus*, Matt., and a Liostracus near *L. Ouangondianus*, Hartt. From the same locality came an Acrothele apparently *A. Matthewi*, Hartt, which might indicate either the Paradoxides or the Protolenus zone.

The section was of special interest to the author as showing that below the Paradoxides beds there was a continuous section of underlying, and not greatly disturbed, measures that gave promise of older faunas; in fact, Mr. Howley indicated several horizons with obscure fossils, and a limestone with *Agraulos strenuus* and *Straparollina remota*.

The section (Fig. 3) shown in this article is practically Mr. Howley's section reduced to one-tenth of his scale, with the dips preserved as he gave them, but with some data and a classification added by the author. By this section it becomes apparent that in this basin of Palæozoic sediments we have two terranes, of which the overlying one has a higher dip than that beneath.

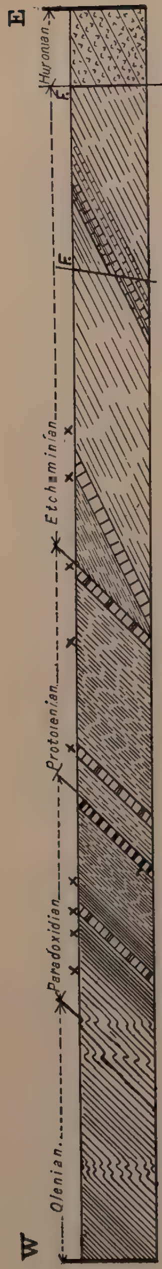

FIG. 3. Section of Eopalæozoic at Smith Sound, Newfoundland. Scale 600 feetto 1 inch. Crosses indicate where fossils are found.

From the direction of the dips it would appear that when the Cambrian (the upper) series was deposited upon the Etcheminian, these rocks had been tilted in a direction the opposite of that which now effects them, and had been eroded chiefly on the landward (western) side.

If, as the writer has inferred in a previous part of this paper, the Etcheminian sediments in the "Atlantic coast" province[1] of the Cambrian sea were in an incoherent state, erosion would proceed rapidly. The exception to this rapid destruction would be the limestones, which would have already become consolidated, and would supply an abundance of blocks and boulders to the new terrane.

Besides the limestone bed shown in this section the eastern basin of Eopalæozoic rocks on Smith Sound shows a lower bed of limestone, and as the measures intervening between the limestones in both basins show great numbers of layers studded with nodular calcareous masses, an abundance of material for building up limestone conglomerates existed in this eastern part of Newfoundland over which the Etcheminian terrane was spread.

As a consequence, it happened that while the deposits of the Protolenian and Paradoxidian zones were accumulating, every debacle of a more violent character tore from the land and spread over the sea-bottom the ruins of these Etcheminian limestones and nodular deposits. As will be seen by the section there are two such fragmental beds in the Protolenus zone and one or more in the Paradoxides zone in this basin on Smith Sound, and similar deposits occur in the Protolenus zone at Manuel's Brook.

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[1] U. S. Geol. Surv. Bull. 81, Pl. I.

It will readily be seen that a careful discrimination must be exercised in separating the fossils occurring in the limestone boulders from those that belong to the paste of the conglomerate, otherwise the fossils of the Etcheminian terrane will be accredited to the Cambrian system. This commingling of species is less likely to mislead in the conglomerates of the Paradoxides zones, where the paste is usually gray, than in the Protolenus zone, where it is usually red, and paste and pebble seem of equal antiquity. Still more misleading are the conditions when, as is frequently the case, the limestone blocks are imperfectly rounded, and seem portions of a limestone paste formed *in situ*.

The two Eopalæozoic basins in Smith Sound are separated by a wide area of strata of the Intermediate (Huronian) series, chiefly the slates of the "d" division, and the sandstones or quartzites of the "e" division. The whole of this system was injected with trap and greatly eroded before the Etcheminian time. Resting upon these gray beds on their eastern side is a comparatively narrow band of tough, feldspathic, red (and greenish), heavy bedded sandstones and slates, which separate the gray beds from the lowest recognizable Etcheminian; these are perhaps a part of "f" of the Intermediate system. They are mentioned here because their red beds seem to have furnished the numerous fragments of red slate, which, in this basin of Palæozoics, form the bulk of the basal conglomerate of the Cambrian part of the deposit. This conglomerate is much heavier than that of corresponding age in the western basin, and is exposed for hundreds of yards along the shores of the sound.

It would thus appear that in both basins, at least so far as the exposures along this shore of the sound give any clue to the matter, the materials of the basal conglomerate were swept from the westward into the basins, and were in close proximity to the place of deposit.

It is quite possible that the cause which led to the production of the basal and interraned conglomerates of the Cambrian (which in all probability was a disturbance and uplifting of the earth's crust) may have operated in a milder way in the earlier Etcheminian time, and have produced the limestone beds in Newfoundland, and the flags and conglomerates which in New Brunswick form the middle part of the terrane. In this view the limestone beds would mark a shoaling and clearing of the sea water in this district of eastern Newfoundland while the pure shale beds, and especially those having layers beset with calcareous nodules, would mark the deeper water. We suppose (though their structure has not been investigated) that these nodules may be due to some sedentary protozoan or to accumulations of errant protozoans, on account of their peculiar growth and structure, which will be described in a future article.

The limestone beds of the Cambrian, as we have said, are due to different conditions of accumulation from those of the Etcheminian. That they are littoral is seen from the abundance of coarse material which they contain, as well as to the lumps and grains of phosphate of lime, and the nodules of hematite with which they abound. At Smith Sound, in the lowest conglomerate bed, the former mineral is common; while in the next, hematite is so plentiful as to form a thin bed of iron ore; a limestone conglomerate occurs in the Paradoxides zone on this sound in which the upper boulders are peppered over with particles of phosphate of lime, as we now often see rocks on the seashore coated with barnacles; this indicates clear water and quiet conditions after the boulders were deposited. These little, round grains of phosphate may have been the moulds of minute organisms which have fallen to the bottom of the sea and lodged upon the stones accumulated there.

In conclusion it may be said that we have in the Eopalæozoic basins of Smith Sound two separate terranes: the *Etcheminian* of which the summit and base are not visible, and which contains true limestones, and the *Cambrian*, of which the limestone beds are fragmental, and which has a definite base as shown by the fauna, the structure and the lithological characters.

The Sections at Manuel's Brook.—While waiting in St. Johns, Newfoundland, for a train to go northward to Smith's

Sound, the author took opportunity to spend a day at Manuel's and on Conception Bay. The section in the gorge at Manuel's Brook has been so well and so fully described by Mr. Walcott that the author had no occasion to seek for other data; he has, therefore, for comparison with the section at Smith Sound, constructed the accompanying section (Fig. 4) on the data given by that author.[1]

As in the case of the Smith Sound section, the difference between the Olenian and Paradoxidian is arbitrary, but the limit between the two lower Cambrian zones is fairly well defined by fossiliferous outcrops. The dip of the beds as given by Mr. Walcott is 12°. Here, as at Smith's Sound, it will be noted that the Cambrian begins with a conglomerate, but this, in place of resting on the soft shales of the Etcheminian, as at that place, is based on Huronian gneisses, felsites and ash rocks, and from these the pebbles of the conglomerate have been derived. But it seems highly probable that the ruins of the Etcheminian are also represented in these boulder-beds, as Mr. Walcott says that there are "irregular masses of limestone on and among the boulders of gneiss, forming the base of the Olenellus zone at Manuel's Brook," and these are said to contain fossils.

There are also certain red slates in the lower part of the Cambrian here which are similar to those at the same horizon on Smith Sound, but at the latter place the red shales are in much greater mass.

The correspondence of these two sections is obvious, as the genus *Protolenus* is found in

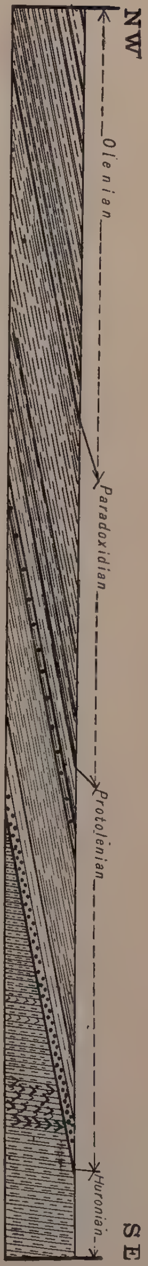

Fig. 4. Section of Cambrian at Manuel's Brook, Newfoundland. Scale 900 feet to 1 inch.

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[1] U. S. Geol. Survey Bull. 81, p. 260.

both at the top of the basal conglomerate. It is plain therefore, that the Etcheminian terrane was entirely eroded at Manuel's Brook before the first member of the Cambrian was laid down, though perhaps the harder calcareous masses remained to contribute to the boulders in the conglomerate. This is parallel to the conditions in New Brunswick on the Kennebecasis River, except that there are no limestones or remains of them in that valley, and the Etcheminian is entirely wanting.

4. The Etcheminian Fauna distinct from the Cambrian.

If there is a break in the geological succession, such as we have shown by the above sections, there should be some differences to mark it between the faunas of the two terranes. This we find to be the case, and believe the difference to be an important one.

In the Etcheminian beds the author has found no trilobites, though other classes of animals, such as Gasteropods, Brachiopods and Lamellibranchs, occur, with which trilobites elsewhere are usually associated in the Cambrian and later geological systems; and the absence (or rarity?) of the latter appears to have special significance, since they are the most notable fossils of the Cambrian deposits, and serve better than any other organisms to differentiate the several zones of that important system.

The fossils which are most abundant and most characteristic of the Etcheminian of Trinity Bay, Newfoundland, are shells of the genera *Hyolithes* and *Orthotheca*, not distinguishable in size or general appearance from the usual forms of the Cambrian. Conical shells resembling *Palæacmæa*[1] are rather common, and others belonging to the genus *Scenella*. The shells of Gasteropoda outside of those named above, as well as the Brachiopoda and Lamellibranchiata, are small, almost minute. We have thus far found no Linguloid brachiopod, nor any Acrothele in this terrane, though they are common in the Protolenian zone of the Cambrian in New Brunswick.

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[1] Such shells are usually referred to *Stenotheca*, but, as the author has shown in previous publications, this name is not applicable.

Adding to the Etcheminian fauna of Newfoundland that of southern New Brunswick we have the following forms (macroscopic):

	Species.		Species.
Hyolithes	2	*Hyolithellus*	2
Orthotheca.	4	*Helenia*	1
Urotheca n. gen.	1	*Palæacmæa*	1
Aptycopsis	1	*Scenella*	2
Kutorgina (?)	1	*Platyceras*	3
Obolella	1	*Modiolopsis*	1
Obolus	1	*Platysolenites* (?)	1
Coleoides	1		

Coral-like forms (Protozoans), fragments of Cystidians and burrows and trails of marine worms, including Arenicolites and Psammichnites.

The uniformity of conditions attending the depositions of the Etcheminian terrane throughout the Atlantic Coast province of the Cambrian is surprising, and points to a quiescent period of long continuance during which the Hyolithidæ and Capulidæ developed so as to become the dominant types of the animal world, while the Brachiopods, the Lamellibranchs and the other Gasteropods still were puny and insignificant. The crustacea so far as we know, were represented only by one Phyllocarid and the trilobites so far have not been recognized at all.

Dana has said that "if strata should be found containing no Trilobites, but only Worms, the lower types of Brachiopods, Ostracods among the Crustaceans, and other inferior species, a place in the Cambrian would properly be made for it."[1] To the author it appears that while a place might for convenience be found in the Cambrian for such a fauna, it would not be "properly found," if we regard its biological significance. To assign such a fauna to the Cambrian would be to ignore the importance of the trilobites in distinguishing from each other the several life-zones of the Cambrian system; we would not recognize as Cambrian a varied fauna from which the trilobites were absent.

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[1] Manual of Geology, 4th ed., pp. 487–488.

But the Etcheminian is not such a fauna as that described by Dana, for it has the marks of advancement and development in it and the dominance of one class over others. The Hyolithidæ had at this time reached as high a development structurally as they ever attained. While not having the diversity of ornamentation, or varieties of shape which they afterward exhibited, they had already reached a high standard as regards their general structure. Gerard Holm, in his standard memoir on the Hyolithidæ and Conulariidæ of Sweden, divides Hyolithes (sens. strict.) into two great sections, viz: *Equidorsati*, in which the boundary between the real dorsal and ventral sides is at the lateral edge of the shell; and *Magnidorsati* in which the real division between these two sides (*i. e.*, the place where the growth-lines change their course) is on the dorsal. Both of these sections are found among the Hyolithes of the Etcheminian Fauna. The Hyolithidæ then were highly developed in this fauna, and dominated all other forms, burrowing worms excepted, in numbers and size.

5. Extension of the Etcheminian to the Westward.

Having found the physical history of the Etcheminian terrane so constant and parallel in the two regions of New Brunswick and Newfoundland, 600 miles apart, I took advantage of an opportunity presented to me through the courtesy of Prof. W. O. Crosby, at the time of the meeting of the American Association for the Advancement of Science in Boston, to see the shales at Braintree. Dr. Crosby first showed me the red slates near Braintree which have been referred to the Olenellus zone, and I was at once struck by their resemblance to the Etcheminian of Newfoundland. These slates are said to underlie the trilobite slates of Braintree, but they are separated from these by a granitic intrusion; this granite has so far affected the calcareous masses found in the red slates that the borders of such bodies are epidotized and the rock has an appearance of greater antiquity than the red shales and slates of Newfoundland. But there are the same occasional limestone beds and the same layers beset with calcareous nodules, which we have remarked in the Etcheminian of Smith Sound. As I learn from Dr. Crosby, the fauna found in these red slates includes many of the types which I have specified, as characteristic of the Etcheminian fauna, and no trilobites have with certainty been obtained from them. Whether these red slates are Etcheminian or not, future investigation will determine, but it may with certainty be affirmed that the conditions of deposition closely resemble those of the Etcheminian of Newfoundland. Red slates have been studied at Nahant near Salem, which have yielded Hyolithidæ and other fossils, and are probably of the same age as the red slates near Braintree.

The lowest Cambrian zone has not been recognized at this locality by its characteristic fossils, and the space where it should occur is occupied by the granitic intrusion above referred to, but at North Attleborough, some distance to the westward of Boston, a Cambrian fauna was found some years ago by Messrs. Shaler and Foerste, and the fauna described by these authors. As the trilobites all have continuous eyelobes, and the species *Microdiscus bellicinctus* is common to this locality and the Protolenus zone in Newfoundland, it is evident that this fauna is Protolenian. The group of trilobites to which the above *Microdiscus* belongs, have a series of tubercles along the anterior marginal fold, which had a functional meaning. Though not found at St. John, these trilobites are evidently characteristic of the Protolenus fauna series; they occur with it at Attleborough and Conception Bay; but they are also a common constituent of the Cambrian fauna at Troy, N. Y., it seems therefore highly probable that the Troy fauna in part at least, belongs to the Protolenus zone, but with considerable variation from the typical facies. The fauna is found in its integrity only in the areas over which the Etcheminian fauna is known to be spread.

It is a disappointment to the writer that he has not been able to find Olenellus (sens. strict.)[1] in any of the sediments described in this paper, which are spread for a thousand miles along the Atlantic coast of America. This has debarred him from using the name Olenellian for any Cambrian fauna in the Atlantic region. This region had a physical history different from that of the interior and the St. Lawrence Valley, from the beginning of the Etcheminian to the middle of the Ordovician, and had faunas more closely allied to those of Europe, than to the parts of America to the north and west. This has been signalized by Dana in his descriptions of the "Eastern Border Region," and stands out distinctly in the earliest Palæozoic time —the Etcheminian.

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[1] As represented in *O. Thompsoni*, Hall, *O. Gilberti*, Meek, ? *O. Iddingsi*, Walc. and *O. Lapworthi* and *O. reticulatus*, Peach.

St. John, N. B., Canada, Nov., 1898.

[ANNALS N. Y. ACAD. SCI., Vol. XII, No. 3, pp. 57 to 86, April 9, 1899.]

NEW YORK ACADEMY OF SCIENCES.

SIXTH ANNUAL RECEPTION.

April 19 and 20, 1899.

CATALOGUE OF EXHIBITS.

NEW YORK

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1899

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and Exhibit of

Recent Progress in Science

at the

American Museum of Natural History.

WEDNESDAY, APRIL 19:
RECEPTION TO MEMBERS OF ACADEMY AND INVITED GUESTS,
8–10 P. M.

THURSDAY, APRIL 20:
AFTERNOON EXHIBIT, 3–5 P. M.
EVENING RECEPTION, TO MEMBERS OF THE SCIENTIFIC
ALLIANCE, 8–10 P. M.

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Persons desiring to join the Academy or support its scientific work by subscription in either of the lines suggested above should address

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A

ANATOMY.

IN CHARGE OF JOSEPH A. BLAKE.

1. MORPHOLOGY OF THE AMPHIBIAN VASCULAR AND VISCERAL SYSTEMS. From the Department of Anatomy, Columbia University. Exhibited by Prof. George S. Huntington.
2. DRAWING ILLUSTRATING VARIATIONS OF THE HEPATIC ARTERY IN FORTY CONSECUTIVE DISSECTIONS. From the Department of Anatomy, Columbia University. Exhibited by Dr. George E. Brewer.
3. SPECIMENS SHOWING TYPES OF THE HUMAN ILEO-COLIC JUNCTION AND VERMIFORM APPENDIX IN THE ADULT AND CHILD. From the Department of Anatomy, Columbia University. Exhibited by Dr. K. Walton Martin.
4. SPECIMENS ILLUSTRATING THE CELLOIDIN CORROSION MASS. From the Department of Anatomy, Columbia University. Exhibited by Dr. Joseph A. Blake.
5. RECONSTRUCTIONS AND DRAWINGS ILLUSTRATING THE STRUCTURE AND DEVELOPMENT OF THE FOURTH VENTRICLE. From the Department of Anatomy, Columbia University. Exhibited by Dr. Joseph A. Blake.
6. SPECIMENS OF ZOÖMETRIC IMPREGNATION CASTS. Exhibited by the Department of Anatomy, Columbia University.

B

ASTRONOMY.

IN CHARGE OF JOHN KROM REES.

ILLUSTRATIONS OF RECENT WORK, 1898 AND 1899.

Exhibited by Harvard College Observatory; E. C. Pickering, Director. 1–21.

1. The Cluster ω Centauri, showing 125 variable stars.
2. Light Curves of Variable Stars in ω Centauri.

3. Comparison of the Potsdam and the Harvard Photometric measures of the variable stars U Vulpeculæ and S T Cygni.
4. Photographic Method of Discovering Variable Stars of Short Period.
5. Meteors photographed on November 14, 1898, showing radiant point.
6. Distribution of Stars of Type V.
7. Specimens of Stellar Spectra, Types I., I., III.
8. Specimens of Stellar Spectra, Types III., IV., V.
9. Specimens of Stellar Spectra, peculiar.
10. Method of converting Prismatic into Normal Spectra.
11. Method of converting Prismatic into Normal Spectra.
12. The New Planet Eros (433); Bruce Telescope.
13. The New Planet Eros (433); Bruce Telescope.
14. Path of Eros in 1894, showing positions of images found on Harvard photographs.
15. The New Star in Sagittarius.
16. New Satellite of Saturn.
17. New 12-inch Horizontal Photometer; exterior.
18. New 12-inch Horizontal Photometer; interior.
19. Ascent of El Misti.
20. Interior of crater of El Misti.
21. Stations on El Misti; elevation 15,700 and 19,200 feet.

LICK OBSERVATORY, CALIFORNIA; James E. Keeler, director.

22. Campbell's photographs of the total solar eclipse of January 21, 1898.
23. Photographs of the Orion Nebula taken with the Crossley reflector.
24. Enlargements of Campbell's photographs of star spectra.

WARNER AND SWAZEY, CLEVELAND, OHIO.

25. New Model Telescopic gun sights.
26. Sextant.
27. Latest design of 2-inch Alt-Azimuth Telescope.

COLUMBIA UNIVERSITY OBSERVATORY; J. K. Rees, director.

28. Graphical representation of the variation of latitude at New York City from 1893 to 1899.

29. Photographs of ancient Chinese instruments.
30. Loewy and Puiseaux's latest enlargements of photographs of the Moon, taken with the Paris Equatorial Coudé.

PUBLICATIONS OF THE OBSERVATORY STAFF:

31. *a.* Vol. I. Rutherfurd's Stellar Photographs by Rees, Jacoby, Davis and Schlesinger.
  b. *Astronomical Journal*, Nos. 401 and 451, giving "The Variation of Latitude at New York and a determination of the constant of aberration from Observations at the Observatory of Columbia University" by Rees, Jacoby and Davis.
  c. *Bulletin Imperial Academy of St. Petersburg* on "Photographic Researches near the Pole of the Heavens," by Jacoby.
  d. *Contributions Nos. 12, 13 and 14 from the Observatory of Columbia University* on "A Catalogue of 65 stars near 61 Cygni," "The parallaxes of 61^1 and 61^2 Cygni," and "A catalogue of 34 stars near Bradley 3077," by Davis.
  e. *Contribution No 15 from Observatory of Columbia University* on "The Præsepe Group: Measurement and Reduction of the Rutherfurd Photographs," by Frank Schlesinger.
32. Elements of DQ—(433) Eros—with projection of orbit on ecliptic plane with Mars and Earth.
33. Path of pole of axis of Earth's figure around axis of rotation. Exhibited by Dr. S. C. Chandler, of Cambridge, Mass.
34. Glass positives showing spectroscopic proof of iron, etc., in the Sun. Exhibited by Professor J. S. Ames, Johns Hopkins University.
35. Glass positives showing rotation of the Sun by displacement of lines in spectrum (Doppler principle). Exhibited by Professor J. S. Ames, of Johns Hopkins University.

YERKES OBSERVATORY, UNIVERSITY OF CHICAGO, George E. Hale, Director.

36. Collection of photographs illustrating the work of the Observatory staff.

C

BOTANY.

IN CHARGE OF C. C. CURTIS.

1. EXHIBIT BY THE NEW YORK BOTANICAL GARDEN.
    - *a.* Architect's designs of the Museum Building and Horticultural Hall now in course of construction.
    - *b.* Illustrations of methods of exhibiting specimens in the Botanical Museum.
    - *c.* Photographs of various portions of the Botanical Garden, including Buildings.
2. PUBLICATIONS OF THE TORREY BOTANICAL CLUB AND ITS MEMBERS.
    - *a.* Bulletin of the Torrey Botanical Club.
    - *b.* Fern Bulletin.
    - *c.* Plant World.
    - *d.* Illustrated Flora of the Northern States and Canada, Vol. III. by Professor N. L. Britton and Addison Brown.
    - *e.* Flora of the Upper Susquehanna by W. N. Clute.
    - *f.* Monograph of the North American Potentilleæ by P. A. Rydberg.
3. *a.* SOME NEW FERNS FROM MEXICO AND THE SOUTHWESTERN UNITED STATES.
    - *b.* NEW FUNGI FROM MAINE.
      Exhibited by Professor L. M. Underwood.
    - *c.* COLORED PHOTOGRAPHS OF PERISHABLE FUNGI.
      Exhibited by J. A. Anderson.
4. PHOTOGRAPHS ILLUSTRATING DISEASES OF PLANTS.
   Exhibited by Professor B. D. Halsted.
5. MOSSES NEW TO THE EASTERN UNITED STATES.
   Exhibited by Mrs. E. G. Britton.

6. EXAMPLES AND ILLUSTRATIONS OF NEW HEPATICAE FROM CALIFORNIA. Exhibited by Dr. M. A. Howe.

7. SOME INTERESTING MOSSES OF NORTH AMERICA, with explanatory notes. Exhibited by Dr. A. J. Grout.

8. NEW GRASSES FROM EASTERN AND SOUTHERN NORTH AMERICA. Exhibited by G. V. Nash.

9. STUDIES OF THE ASCLEPIADACEAE AND LEGUMINOSAE OF NORTH AMERICA.
Exhibited by Miss Anna Murray Vail.

10. STUDIES IN THE LOCAL FLORA.
Exhibited by E. P. Bicknell.

11. UNDESCRIBED PLANTS OF THE SOUTHERN UNITED STATES. Exhibited by Dr. J. K. Small.

12. PLANTS NEW TO THE VICINITY OF NEW YORK.
Exhibited by W. N. Clute.

13. PREPARATIONS AND ILLUSTRATIONS OF A PARASITE OF THE ERYSIPHACEÆ. Exhibited by D. Griffiths.

14. STUDIES IN THE LIFE HISTORY OF *Sphærella lacustris*.
Exhibited by T. E. Hazen.

15. PREPARATIONS AND DRAWINGS, ILLUSTRATING THE EMBRYOLOGY OF THE RUBIACEÆ.
Exhibited by Professor Francis E. Lloyd.

16. *a*. SPERMATOGENESIS OF *Pellia*.
b. FRUITING TIPS OF *Sargassum*.
Exhibited by Dr. W. R. Shaw.

17. DEVELOPMENT OF EMBRYO-SAC OF *Delphinium exaltatum*.
Exhibited by Miss L. B. Dunn.

18. *a*. EFFECTS OF CHEMICAL IRRITANTS UPON CERTAIN FUNGI.
b. FORMALIN AS A PRESERVATIVE OF ALGÆ.
Exhibited by Dr. H. M. Richards.

19. A SELF-RECORDING AUXANOMETER FOR CLASS DEMONSTRATION. Exhibited by Professor J. C. Arthur.

20. A CONVENIENT MANOMETER FOR ROOT PRESSURE.
Exhibited by Dr. C. C. Curtis.

D

CHEMISTRY.

IN CHARGE OF CHARLES A. DOREMUS.

1. SPECIMENS OF EFFECT PRODUCED ON METALS BY THE DETONATION OF EXPLOSIVES.
   Exhibited by Charles E. Monroe.

2. BASE OF SIX-INCH CARTRIDGE CASE FOUND ON THE DECK OF THE VISCAYA AFTER THE BATTLE, EXPLODED BY HEAT OF FIRE.
   Exhibited by W. W. Gilmartin, gunner, U. S. Navy.

3. SOME CHEMICAL PRODUCTS USED IN THE MANUFACTURE OF EXPLOSIVES. Exhibited by C. W. Volney.

4. APPARATUS FOR CONTINUOUS FILTRATION AND EXTRACTION.
   Exhibited by C. W. Volney.

5. PROGRESS IN ARTISTIC GLASS.
   Exhibited by Louis C. Tiffany.

6. AN APPARATUS FOR THE EXTRACTION OF SOLIDS WITH AN ATTACHMENT FOR THE EXTRACTING ONE LIQUID BY ANOTHER. Exhibited by Aug. E. Knorr.

7. AN APPARATUS FOR THE SEPARATION OF ARSENIC, ANTIMONY, SELENIUM AND TIN BY FRACTIONAL DISTILLATION.
   Exhibited by Aug. E. Knorr.

8. GUAIACOL.
   a. Guaiacolsulphonic acid (crude).
   b. Barium Guaiacolsulphonate.
   c. Sodium Guaiacolsulphonate.
   d. Acetylguaiacol Sodium sulphonate.
   Exhibited by Ludwig H. Reuter.

9. SAMPLES SHOWING THE MANUFACTURE OF PURE LITMUS.
   Exhibited by Ludwig H. Reuter.

10. β NAPHTALENESULPHONIC ACID AND BENZENESULPHONIC ACID FOR THE MANUFACTURE OF ETHERS AND ESTHERS.
    Exhibited by Ludwig H. Reuter.

11. PHENYLDIMETHYLPYRAZOLONE-SULPHONIC ACID (crude).
    - *a.* Morphine Phenyldimethylpyrazolonesulphonate.
    - *b.* Codeine Phenyldimethylpyrazolonesulphonate.
    - *c.* Caffeine Phenyldimethylpyrazolonesulphonate.
    - *d.* Quinine Phenyldimethylpyrazolonesulphonate.
    - *e.* Barium Phenyldimethylpyrazolonesulphonate.

    Exhibited by Ludwig H. Reuter.

12. FIVE SAMPLES SHOWING THE MANUFACTURE OF ACETYL DERIVATIVES OF SULPHONATES OF PHENOLS.
    Exhibited by Ludwig H. Reuter.

13. CARBOLIC ACID (Merk & Co.) REMAINING PERFECTLY WHITE UNDER USUAL PRECAUTIONS IN KEEPING.
    Exhibited by Ludwig H. Reuter.

14. *a.* HEXAMETHYLENETETRAMINE SULPHATE.
    - *b.* HEXAMETHYLENETETRAMINE ETHYSULPHATE.

    Exhibited by Ludwig H. Reuter.

15. A SERIES OF THE APPROXIMATE CONSTITUENTS OF TRINIDAD LAKE ASPHALT. Exhibited by Clifford Richardson.

16. PHENOLS FROM CALIFORNIA PETROLEUM.
    Exhibited by Clifford Richardson.

17. A SOAP CONTAINING 25 TO 30% OF KEROSENE. Exhibited by Hermann Poole and Ralph W. Bailey.
    - *a.* A soap containing 40% of paraffine oil.
    - *b.* A soap containing 50% paraffine wax.
    - *c.* An ointment, base Permol, which will not become rancid.
    - *d.* Various ointments with base Permol.
    - *e.* A solid ammonia soap.

    Exhibited by Hermann Poole and Ralph W. Bailey.

18. TELLURIUM EXTRACTED BY SUGAR.
    - *a.* Raw material.
    - *b.* Pure tellurium oxide. Exhibited by Victor Lenker.

19. COLORIMETER.
    Exhibited by Jerome Alexander.

20. APPARATUS FOR TESTING FOR ALUM IN WATER FILTRATION.
    Exhibited by C. A. Doremus.

21. *a.* PARAFFINE, extracted from commercial oleomargarine.
b. ARTIFICIAL COFFEE BEANS.
Exhibited by Joseph F. Geisler.

E

ELECTRICITY.

IN CHARGE OF GEORGE F. SEVER.

1. EXHIBIT OF NEW APPARATUS BY QUEEN & CO. THROUGH O. T. LOUIS.
a. A new complete incandescent lamp Photometer.
b. A sensitive simple D'Arsonval Galvanometer.

F

ETHNOLOGY AND ARCHÆOLOGY.

IN CHARGE OF LIVINGSTON FARRAND.

1. DECORATIONS AND PROPERTY MARKS ON ESKIMO HARPOONS. From the Collection of the American Museum of Natural History. Exhibited by Franz Boas.

2. INDIAN BASKETS FROM WASHINGTON AND BRITISH COLUMBIA, illustrating the development of conventional designs. Collected for the Jesup North Pacific Expedition by Livingston Farrand and James Teit.

3. A NEW FORM OF HIEROGLYPHIC WRITING FROM MEXICO. Collected for the American Museum of Natural History by M. H. Saville.

4. TYPES OF HAND HAMMERS AND PESTLES FROM THE NORTH PACIFIC COAST OF AMERICA. From the collection of the American Museum of Natural History.
Exhibited by Harlan I. Smith.

5. PHOTOGRAPHS OF ARCHÆOLOGICAL SPECIMENS FROM WESTERN NEW YORK AND SARATOGA COUNTY.
Exhibited by W. L. Hildburgh.

G

EXPERIMENTAL PSYCHOLOGY.

In Charge of Chas. H. Judd.

1. New Ergographs.
   Exhibited by Professor J. McKeen Cattell.
2. Methods and Apparatus for the Study of Accuracy of Movement.
   Exhibited by Mr. R. S. Woodworth, Columbia University.
3. Apparatus for the Study of Binocular Rivalry.
   Exhibited by Mr. B. B. Breese, Columbia University.
4. Simple Photometer for Measuring Light Intensities in Schools.
   Exhibited by Mr. G. E. Johnson, New York University.
5. Charts of Optical Illusions.
   Exhibited by Professor Chas. H. Judd, New York University.

H

GEOLOGY AND GEOGRAPHY.

In Charge of J. F. Kemp and R. H. Cornish.

1. Geological and Topographical Model Illustrating the Yellowstone National Park, prepared for exhibition at the Paris Exposition in 1900. (Modeled by E. E. Howell.) Exhibited by U. S. Geological Survey, Washington, D. C.
2. Series of Maps Showing the Topographic Work of the U. S. Geological Survey.
   - *a.* Printed map to show the progress of topographic mapping by the survey in the Eastern third of the United States in 1898.
   - *b.* Hand-colored map of New York State showing progress in topographic mapping last year.
   - *c.* Five wall maps of portions of New York State, in-

cluding new sheets and old ones, viz:
The new map of New York city, 2′, 9″ by 3′, 8″.
The Lower Hudson, 11′, 8″ by 1′, 1″.
The Adirondacks, 4′, 4″ by 5′, 10″.
Syracuse to Utica, 5′, 5″ by 1′, 6″.
The eastern end of Lake Ontario, 3′, 3″ by 1′, 6″.
Niagara Falls to Rochester, 6′, 6″ by 2′, 9″.

3. SERIES OF MAPS AND PUBLICATIONS TO SHOW PROGRESS IN GEOLOGY:
   - *a.* The Holyoke, Mass.; Butte, Mont.; Ten Mile, Colo.; Boise, Idaho; and Nereces, Texas, Folios.
   - *b.* Wall maps of the London and Richmond sheets, Ky.
     - Wall maps of the Little Belt Mtns.; Ft. Benton and Livingston sheets Mont.
     - Wall maps of Tazewell and Pocahontas sheets, Virginia.
     - Wall maps of Fredericksburg and Nomini sheets, Maryland.
     - Wall maps of Truckee, Pyramid Park, Big Trees and Sonora sheets, California.
     - Wall maps of Holyoke sheets, Massachusetts.
   - *c.* Eighteenth Annual Report of the Director of the U. S. Geological Survey.
   - *d.* Monograph XXVIII. and Atlas.
   - *e.* Physiographic Folio.

   Exhibited by U. S. Geological Survey, C. D. Walcott, Director.

4. *a.* RECENT PUBLICATIONS OF THE NEW YORK STATE MUSEUM, Albany, N. Y.
   - *b.* RELIEF MAP OF THE EASTERN ADIRONDACKS.

   Exhibited by Dr. F. J. H. Merrill, State Geologist of New York.

5. *a.* VARIOUS CRUDE PETROLEUMS FROM THE EAST INDIES, JAPAN, ETC.
   - *b.* NEW GEOLOGIC MAP OF WEST VIRGINIA, prepared by I. C. White, State Geologist.

Exhibited by Professor J. J. Stevenson, of New York University.

6. *a.* MAP SHOWING THE GEOLOGY OF MARYLAND, SCALE 2″ TO THE MILE.
   b. Map showing the relative elevations of Maryland, scale 2″ to the mile.
   c. Map showing the physiographic provinces of Maryland, scale 2″ to the mile.
   d. Map showing the divides and drainage basins of Maryland, scale 2″ to the mile.
   e. Framed chart showing Maryland building and decorative stones.
   f. Framed chart showing the physical features of Maryland.
   g. Framed chart showing the quarries and quarry areas of Maryland.
   h. Reports of the Maryland Geological Survey.
   Exhibited by the Maryland Geological Survey through Professor W. B. Clark, State Geologist.

7. SERIES OF SPECIMENS ILLUSTRATING THE EFFECT OF MINERALOGICAL COMPOSITION UPON THE FUSIBILITY OF CLAY.
   Exhibited by Dr. Heinrich Ries, Cornell University.

8. SERIES OF SPECIMENS OF ROCKS, DIAGRAMS, PHOTOGRAPHS AND ORES, ILLUSTRATIVE OF THE NORTHERN BLACK HILLS, SOUTH DAKOTA. (Paper read before the Academy, March 20, 1899.)
   Exhibited by John D. Irving, Fellow in Geology, Columbia University.

9. SERIES OF SPECIMENS OF ROCKS, ILLUSTRATING THE GEOLOGY OF SONORA, MEXICO, NOW UNDER INVESTIGATION.
   Exhibited by B. F. Hill.

10. *a.* TEN LARGE THIN-SECTIONS OF ADIRONDACK ROCKS, ILLUSTRATING DYNAMIC METAMORPHISM.
    b. SPECIMENS, PLATES AND PHOTOGRAPHS, ILLUSTRATING THE GEOLOGY OF THE TITANIFEROUS MAGNETITES. (Paper read before the Academy, February 20, 1899.)
    Exhibited by Professor J. F. Kemp.

11. SERIES OF ABRASIVES, NATURAL AND ARTIFICIAL, VIZ. CORUMDUM FROM ONTARIO, CANADA, SHOOTING CREEK, N. C., CARBORUNDUM FROM NIAGARA FALLS, N. Y. Exhibited by G. F. Kunz and J. F. Kemp.

I

MINERALOGY.

IN CHARGE OF ALFRED J. MOSES.

1. EXHIBIT OF DEPARTMENT OF GEOLOGY AND MINERALOGY, AMERICAN MUSEUM NATURAL HISTORY, through L. P. Gratacap.
    - *a.* Mass of Corundum Rock, Towns Co., Ga.
    - *b.* Fuggerite, Le Salle, Monzoni, Tyrol.
    - *c.* Lorandite, Allchar, Macedonia.
    - *d.* Herderite (large crystals), Stoneham, Me.
    - *e.* Epididymite, Greenland.
    - *f.* Celestites (groups of large crystals), Strontian Island, Lake Erie.
    - *g.* Series of English Barites.
        - 1. Parkside, Cumberland, Eng.
        - 1. Mowbray, Cumberland, Eng.
        - 2. Dalmellington, Eng.
        - 4. Frizington, Eng.
        - 1. Pallaflat, Cumberland, Eng.
    - *h.* Stilbite, Berufiord, Iceland.
    - *i.* Apophyllite (geode cavity) Berufiord, Iceland.
    - *j.* Phacolite, Melbourne, Australia.
    - *k.* Microcline (Baveno Twin), Crystal Peak, Col.
    - *l.* Crocidolite (unaltered, long fiber), Griqua Land, S. A.
    - *m.* Fluorite (large elongated cube), Northumberland, Eng.
    - *n.* Barite on Calcite (large nodular mass), Bad Lands, S. Dakota.
    - *o.* Large group of associated Galenite, Sphalerite and Chalcopyrite, Joplin, Mo.
    - *p.* Stephanite on Pyrite, Grand Prize Mine, Tuscarora, Elks Co., Nev.

q. Column of Halite (crystallized from natural solution), Great Salt Lake? Utah.
r. Smoky Quartz (colossal crystal), Auburn, Me.
s. Smoky Quartz (parallel crystallization), Auburn, Me.

2. Exhibit of Department of Mineralogy, Columbia University.
    a. Goldschmidt's Two Circle Application Goniometer.
    b. Fuess's Student Goniometer No. IVa.
    c. Goldschmidt's Goniometer Lamp.
    d. Fuess's Pyroelectric Apparatus after Kundt.
    e. Suite of microphotographs showing the figures produced on crystal faces by means of the etching method. Prepared by H. P. Whitlock.
    f. Suite of microscope slides showing etching figures on crystals of Gypsum, Natrolite, Calcite, Rhodochrosite, Siderite, Apatite, Fluorite, Cerussite, Calamine, Pyrite, and Biotite. Prepared by H. P. Whitlock.
    g. Marshite (Copper Iodide) Broken Hill Mines, New South Wales.
    h. Tocornalite (Silver Mercury Iodide), Broken Hill Mines, New South Wales.
    i. Clinohumite, Monte Somma, Vesuvius.
    j. Chalcotrichite, matted, Old Dominion Mine, Arizona.
    k. Hessite, large crystal, Botes, Transylvania.
    l. Alexandrite, large crystal, Emerald Mines, Urals.
    m. Silver, twinned cubes, Lake Superior.
    n. Anglesite, large crystal, Wheatley Mine, Penn.
    o. Ramosite, Ramos, Mexico.
    p. Olivenite, large crystal, Mark Valley Mine, Cornwall.
    q. Capped quartz, England.
    r. Coquimbite Crystals, Atacama, Chili.
    s. Rubellite, Schaitausk, Urals.
    t. Titanite, twin crystals, Renfrew, Ontario.
    u. Beryl, terminated crystals, Mursinka, Urals.

The specimens and apparatus have been acquired by the Department during the year. Specimens *l* to *u* are from the collection of Dr. Thomas Egleston, recently presented to the Department.

3. ERIONITE, DURKEE, OREGON. A New Zeolite, described and exhibited by Arthur S. Eakle, of Harvard University.

4. *a.* PHOTOGRAPHS OF MINERAL SPECIMENS REDUCED OR ENLARGED, "photomicrographs" with society size accessories including lantern slides for lecture illustrations and prints for book illustrations. Made by exhibitor.
   b. APPARATUS FOR PROJECTING THE EFFECTS OF THE PASSAGE OF CONVERGENT POLARIZED LIGHT, through crystals practically after the plan given in Wright's "Light" London. But being made of aluminium it is so light that it is not disposed to sag, and requires no supporting bed. Made by exhibitor.
   c. RAKESTRAWS OF SOCIETY SIZE, showing methods of mounting in special instances.
      1. Attwood cells in rakestraws.
      2. Cover glass cemented on ground surface of specimen.
   d. ACCESSORIES FOR SOCIETY SIZE RAKESTRAWS.
      1. Modern Cartoon designed by Roy Hopping.
      2. Microscope stage attachment for holding Rakestraws during examination, designed by James Walker. Made by William T. Gregg. Exhibited by Wallace Goold Levison.

5. *a.* Large Quartz Twin from Japan.
   b. Green Fluorite from New Hampshire.
   c. Unaltered Crocidolite from South Africa.
   d. Uranium Minerals from Colorado.
   e. Thomsonite and Analcite from Colorado.
   f. Recent finds in the Iron Mines North of England.
   g. Allophane from New Mexico.
   h. Recent Finds near Joplin, Missouri.

   Exhibited by Geo. L. English & Co.

6. *a.* Neptunite, Narsasuk, Greenland.
   b. Epididymite, Narsasuk, Greenland.

c. Elpidite, Narsasuk, Greenland.
d. Catapleiite, Narsasuk, Greenland.
e. Parisite, Narsasuk, Greenland.
f. Rinkite, Kangerdluarsuk, Greenland.
g. Steenstrupine, Kangerdluarsuk, Greenland.
h. Ilvaite, Siorarsuit, Greenland.
i. Aemigmatite, Naryakasik, Greenland.
j. Parisite, Ravalli Co., Montana.
k. Scheelite, Dragoon, Arizona.
l. Scorodite, Tintic District, Utah.
m. White Olivenite, Tintic District, Utah.
n. Red Olivenite, Tintic District, Utah.
o. Green Olivenite, Tintic District, Utah.
p. Penfieldite, Tintic District, Utah.
q. Josephinite, Josephine Creek, Josephine Co., Oregon.
r. Vanadinite, near Bannock City, Montana.

Exhibited by Lazard Cahn.

7. CRYSTALS OF MICA.
Exhibited by Jerame Alexander.

J

PALEONTOLOGY.

IN CHARGE OF GILBERT VAN INGEN.

1. UPPER DEVONIAN BRECCIA WITH FISH REMAINS DEPOSITED IN A SUBTERRANEAN CHANNEL IN THE NIAGARA LIMESTONE. Elmhurst, Illinois. Exhibited by Dr. Stuart Weller, of the University of Chicago.

2–8. Exhibition from the Department of Vertebrate Palæontology, American Museum of Natural History. Mainly the Western Expedition of 1898.

2. DINOSAUR LIMBS.
a. Hind limbs of great Carnivorous Dinosaurs, full-grown and two-thirds grown.
b. Hind limbs of great Herbivorous Dinosaurs, probably two stages of growth of *Brontosaurus*. Exhibited by H. F. Osborn, Curator.

3. SKULL AND FEET OF THE PRIMITIVE CARNIVORE, *Oxyæna*, WITH A RESTORATION OF THE SKELETON.
Exhibited by J. L. Wortman, Assistant Curator.

4. COMPLETE SKELETON OF A JURASSIC TURTLE, *Compsemys*, FROM THE DINOSAUR BEDS OF WYOMING.
Exhibited by J. L. Wortman, Assistant Curator. Museum Expedition of 1898.

5. CHART AND SPECIMENS ILLUSTRATING THE ANCESTRY OF THE DOGS AND RACCOONS.
Exhibited by J. L. Wortman and W. D. Matthew.

6. NEW MEMBERS OF THE CAMEL SERIES, FILLING GAPS IN THE CHAIN OF DESCENT.
Exhibited by J. L. Wortman and W. D. Matthew.

7. NECK AND HIND LIMB OF A GIRAFFE-LIKE CAMEL. A CASE OF INEXACT PARALLELISM.
Exhibited by W. D. Matthew.

8. RESTORATIONS OF EXTINCT ANIMALS OF NORTH AMERICA.
Painted by Charles Knight. Nos. 20–24.
    20. *Phenacodus primævus*, a Condylarth.
    21. *Coryphodon testis*, an Amblypod—male and female.
    22. *Hoplophoreus primævus*, a Sabre-tooth Cat.
    23. *Brontosaurus*, a great Herbivorous Dinosaur.
    24. *Telcoceras fossiger*, a short-limbed Rhinoceros.
Exhibited by H. F. Osborn, Curator.

9. PHOTOGRAPHS OF EURYPTERUS SCORPIONIS AND E. BENNETTI FROM THE WATERLIME GROUP OF BUFFALO, N. Y.
Exhibited F. K. Mixer, Buffalo, N. Y.

M

PHYSICS.

IN CHARGE OF C. C. TROWBRIDGE; PHOTOGRAPHY, IN CHARGE OF CORNELIUS VAN BRUNT.

1. STREMMATOGRAPH, Third Form, with recording tape, to obtain strains under both rails for high speed trains.

2. CAMERA FOR DOUBLE EXPOSURES of 1-100 to 1-1000 of a second of locomotives and trains as they pass over the Stremmatograph, and scale-boards for timing exposures.

3. PHOTOGRAPH OF RUNNING LOCOMOTIVE, exposure 1-500 of a second, showing position of counterbalance in reference to the Stremmatograph.

4. PHOTOGRAPH OF 80 CAR TRAIN, ¾ of a mile long. Gross load 3,400 tons.

5. PHOTOGRAPH OF TRAIN with Goerz five system double Anastigmat.

6. PHOTOGRAPH OF VENUS AND THE MOON, March 8th, 5:30 A. M., lens 120 millimeters focus.

7. 4 SHEETS OF TABULATIONS OF STRESSES in 100-lb. rails taken by the First Form of Stremmatograph.

8. BOSTON AND ALBANY "CONDENSED DIAGRAMS" of track, showing reduction in undulations per year from 1881 to 1898.

Nos. 1–8 exhibited by P. H. Dudley.

9. IMPROVISED STILL for continuous production of distilled water of extreme purity for general laboratory purposes. Exhibited by E. H. Loomis. Princeton University.

10. RESISTANCE VESSEL for electrolytes.
Exhibited by E. H. Loomis. Princeton University.

11. MODIFICATION OF PFAUNDLER'S CALORIMETER for the measurement of the specific heat of solutions.
Exhibited by W. F. Magie. Princeton University,

12. STILL FOR DISTILLING METHYL ALCOHOL (etc.) and determining its specific gravity without contact with atmosphere. Exhibited by E. H. Loomis. Princeton University.

13. CROOKE'S TUBE WITH RADIOMETERS to show unequal distribution of gaseous pressure after discharge.
Exhibited by J. E. Moore. Princeton University.

14. STILL FOR THE PURIFICATION OF WATER for experiments in conductivity. Exhibited by G. A. Hulett. Princeton University.

15. PHOTOGRAPHS OF CURVES showing conductivities of various electrolytes and the hydrolysis of stannic chloride. Exhibited by William Foster, Jr. Princeton University.

16. GLASS POSITIVES comparing metallic and solar spectra.

17. GLASS POSITIVES showing effect on spectra produced by increased atmospheric pressure on the arc.

18. GLASS POSITIVES showing Zeeman effect in spectra.

19. GLASS POSITIVES showing the displacement of spectrum lines by the rotation of the sun. Dopplar principle. Nos. 16–19; taken at John Hopkins University and exhibited by J. S. AMES.

20. MECHANICAL ILLUSTRATION OF KIRCHHOFF'S PRINCIPLE. Exhibited by W. Hallock.

21. THOMPSON DOUBLE BRIDGE, improved form of, for the measurement of low resistance, reading directly to 0.000001 ohm. Manufactured by Hartmann and Braun of Frankfort. Exhibited by H. C. Parker.

22. REICHSANSTALT STANDARD CLARK CELL.
Exhibited by H. C. Parker.

23. BRIDGE FOR THE COMPARISON OF STANDARD OHMS by the Carey-Foster Method. Manufactured by Queen & Co. Exhibited by H. C. Parker.

24. WEHNELT'S ELECTROLYTIC INTERRUPTER, a form of, for induction coils. Exhibited by F. L. Tufts.

25. A PLATINUM THERMOMETER for the measurement of low temperatures.
Designed and exhibited by C. C. Trowbridge.

26. METALLIC BODIES used in determining the specific heat of metals at low temperatures. (+ 15° to – 182°C.) Exhibited by C. C. Trowbridge.

27. Hertz Wave Apparatus. Exhibited by A. E. Lawrence.

28. Effect of an Alternating Current upon the glowing filament of an incandescent lamp producing nodes and loops as in Melde's experiments.
Exhibited by W. C. Peckham. Adelphi College, Brooklyn.

29. Mercury Vacuum Pump; new short form, designed by Boltwood, which requires only 5 lbs. of mercury; will exhaust a vessel of one liter capacity to a cathode ray vacuum in 25 minutes.

30. Polariscope, new half shade instrument with triple field of vision, adopted as United States Standard for sugar polarization.

31. Colorimeter, according to Lovibund. An apparatus for the recording and comparison of colors.

32. Junke's Reading Lens for thermometers.

33. X-Ray Tube for 16-inch spark. For induction or static machine. No platinum used at cathode.

34. Glass Prisms, hollow, plates fused together to stand all acids and alkalies.

35. New Reverberatory Shade and Chimney for Welsbach incandescent light.
Nos. 29 to 35 exhibited by Eimer & Amend.

36. Audimeter. An instrument for the production of standard units of sound intensity, and for the establishment of corresponding units of sensitiveness and defectiveness of hearing. Exhibited by Alfred G. Compton.

37. Electrical Interrupter for Helmholtz's acoustic apparatus and other uses. Exhibited by Alfred G. Compton.

38. Focusing Arc Lamp. Exhibited by Alfred G. Compton.

39. *a.* Chromo-Photographs on paper, of life scenes, instantaneous.
b. Stereoscopic views on glass.
Exhibited by Charles L. A. Brasseur.

O

ZOÖLOGY.

In Charge of Gary N. Calkins.

1. Illustrations of the Nile Fauna. From collection made by the Senff Zoölogical Expedition of 1898, to the Nile. Exhibited by N. R. Harrington.
   - *a. Mormyrus oxyrhynchus.*
   - *b. Malapterurus electricus.* The "electric fish."
   - *c. Polypterus bishir.* The special object of the Expedition.
   - *d.* Various vertebrates and invertebrates from the Nile and the Red Sea.

2. Further Illustrations of the Fauna of Bermuda. From collection made in the summer of 1898 by the New York University Alumni Expedition.
   Exhibited by C. L. Bristol.

3. Illustrations of Bird Habits.
   Exhibited by Frank M. Chapman.
   - *a.* Nesting Habits of the Brown Pelican. Collected by F. M. Chapman on Pelican Island, Florida. Mounted by E. H. Smith.
   - *b.* Photographs of Birds in Nature. Photographed by F. M. Chapman.

4. The Plumages of Certain Passerine Birds of New York, illustrating the changes produced by Moult and by Wear. Exhibited by Jonathan Dwight, Jr.
   - *a.* Bobolink.
   - *b.* Cowbird.
   - *c.* Red-winged Blackbird.
   - *d.* Meadow Lark.
   - *e.* Purple Finch.
   - *f.* Gold Finch.
   - *g.* Scarlet Tanager.
   - *h.* Black-Yellow Warbler.
   - *i.* Red-stark.

5. *a.* Developmental stages of the Stone cat, *Noturus gyrinus.*
   - *b.* A Free-living Tunicate, *Doliolum.*

   Exhibited by F. B. Sumner.

6. *a.* BORN WAX-PLATE MODEL OF THE CRANIUM AND JAWS OF THE LARVAL CHIMÆROID, *Hydrolagus colliei.*
   b. SEGMENTATION STAGES OF THE HAG-FISH, *Bdellostoma stoutia.* Exhibited by Bashford Dean.

7. PREPARATIONS ILLUSTRATING RECENT NEUROLOGICAL METHODS. Exhibited by O. S. Strong.

8. PREPARATIONS ILLUSTRATING THE DEVELOPMENT OF SPERMATOZOA IN THE CRUSTACEA.
   Exhibited by M. Bunting.

9. PREPARATIONS ILLUSTRATING THE EVOLUTION OF THE KARYOKINETIC FIGURE. Exhibited by G. N. Calkins.

10. PREPARATIONS ILLUSTRATING THE MATURATION AND FERTILIZATION OF AN ASCIDIAN.
    Exhibited by H. E. Crampton, Jr.

11. PREPARATIONS ILLUSTRATING CERTAIN STAGES IN THE MATURATION AND FERTILIZATION OF A SNAIL, *Limnæa elodes.* Exhibited by H. R. Linville.

12. PREPARATIONS ILLUSTRATING FORMATION AND DIVISION OF AN ABNORMAL TETRAD IN THE SPERMATOGENESIS OF VARIOUS HEMIPTERA. Exhibited by F. C. Paulmier.

13. *a.* PREPARATIONS SHOWING A METHOD OF HISTOLOGICAL AND CYTOLOGICAL TECHNIK.
    b. DEMONSTRATION OF THE BREATHING APPARATUS OF FISHES.
    Exhibited by Ulric Dahlgren, of Princeton University.

INDEX OF EXHIBITORS.

NAME. PAGE.

Alexander, J. 73, 81
Ames, J. S. 69, 84
Anderson, J. A. 70
Arthur, J. C. 71

Bailey, R. W. 73
Bicknell, E. P. 71
Blake, J. A. 67
Boas, Franz 74
Botanical Garden 70
Brasseur, C. L. A. 85
Brewer, G. E. 67
Breese, B. B. 75
Bristol, C. L. 86
Britton, E. G. 70
Britton, N. L. 70
Bunting, M. 87

Cahn, Lazard, ... 81
Calkins, G. N. 87
Cattell, J. McK. 75
Chandler, S. C. 69
Chapman, F. M. 86
Clark, W. B. 77
Clute, W. N. 71
Compton, A. G. 85
Crampton, H. E., Jr. 87
Curtis, C. C. 71

Dahlgren, U. 87
Davis, H. S. 69
Dean, B. 87
Doremus, C. A. 73
Dudley, P. H. 83
Dunn, L. B. 71
Dwight, J., Jr. 86

Eakle, A. S. 80
English, G. L. 80
Eimer and Amend 85

Farrand, L. 74
Foster, W., Jr. 84

Geisler, J. F. 74
Geological Survey, U. S. ... 75, 76
Gilmartin, W. W. 72
Gratacap, L. P. 78
Grout, A. J. 71
Griffiths, D. 71

Hale, G. E. 70
Hallock, W. 84
Halsted, B. D. 70
Harrington, N. R. 86
Hazen, T. E. 71
Hildburgh, W. L. 74
Hill, B. F. 77
Howe, M. A. 71
Hulett, G. A. 84
Huntington, G. S. 67

Irving, J. D. 77

Name.	Page.
Jacoby, H.	69
Johnson, G. E.	75
Judd, C. H.	75
Keeler, J. E.	68
Kemp, J. F.	77, 78
Knorr, A. E.	72
Kunz, G. F.	78
Lawrence, A. E.	85
Levison, W. G.	80
Lenker, V.	73
Linville, H. R.	87
Lloyd, F. E.	71
Loomis, E. H.	83
Louis, O. T.	74
Magie, W. F.	83
Martin, K. W.	67
Matthew, W. D.	82
Merrill, F. J. H.	76
Mixer, F. K.	82
Monroe, C. E.	72
Moore, J. E.	83
Nash, G. V.	71
Osborn, H. F.	81, 82
Parker, H. C.	84
Paulmier, F. C.	87
Peckham, W. C.	85
Pickering, E. C.	67
Poole, H.	73

Name.	Page.
Queen & Co.	74
Rees, J. K.	68, 69
Reuter, L. H.	72, 73
Richards, H. M.	71
Richardson, C.	73
Ries, H.	77
Saville, M. H.	74
Schlesinger, F.	69
Shaw, W. R.	71
Small, J. K.	71
Smith, E. H.	86
Smith, H. I.	74
Stevenson, J. J.	77
Strong, O. S.	87
Sumner, F. B.	86
Swazey, & Warner	68
Teit, J.	74
Tiffany, L. C.	72
Torrey Botanical Club	70
Trowbridge, C. C.	84
Tufts, F. L.	84
Vail, A. M.	71
Volney, C. W.	72
Walcott, C. D.	76
Warner & Swazey	68
Weller, S.	81
White, I. C.	76
Woodworth, R. S.	75
Wortman, J. L.	82

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CONTENTS OF VOL. XII, PART I.

1.—Charter, Order of Court, Constitution and By-Laws and List of Members of the New York Academy of Sciences, 1899, ... 1

2.—**Matthew, Geo. F.** A Palæozoic Terrane beneath the Cambrian (Figs. 1–4), ... 41

3.—New York Academy of Sciences. Sixth Annual Reception. April 19 and 20, 1899. Catalogue of Exhibits, ... 57